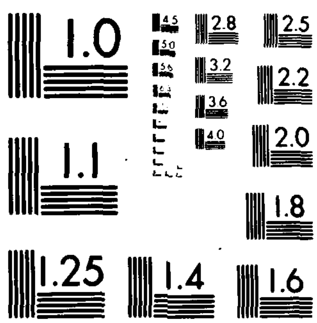
AD-A092 989 PLANNING AND MANAGEMENT CONSULTANTS LTD CARBONDALE IL F/G 13/2
THE EVALUATION OF WATER CONSERVATION FOR MUNICIPAL AND INDUSTRI--ETC(U)
APR 80 D D BAUMANN, J J BOLAND, J H SIMS DACW72-79-C-0018
UNCLASSIFIED IWR-CR-80-1 NL

1 of 1
AD A
092 989

END
DATE
FILMED
1-81
DTIC



MICROCOPY RESOLUTION TEST CHART

AD A092989

CONTRACT NUMBER DACW72-79-C-0018

THE EVALUATION OF WATER CONSERVATION FOR MUNICIPAL AND INDUSTRIAL WATER SUPPLY

Procedures Manual

DEC 17 1980

A

APRIL 1980

CONTRACT REPORT 80-1

APPROVED FOR PUBLIC RELEASE DISTRIBUTION UNLIMITED

DDC FILE COPY

Submitted to
U.S. ARMY ENGINEER
INSTITUTE FOR
IWR
WATER RESOURCES
KINGMAN BUILDING
FORT BELVOIR VIRGINIA 22060

80 12 15 194

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER 14) CR- (18) IWR Contract Report 80-1	2. GOVT ACCESSION NO. AD-A092 989	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) The Evaluation of Water Conservation for Municipal and Industrial Water Supply. Procedures Manual.		5. TYPE OF REPORT & PERIOD COVERED (9) Final
		6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) Duane D. Baumann, John J. Boland, John H. Sims		8. CONTRACT OR GRANT NUMBER(s) (15) DACW72-79-C-0018
9. PERFORMING ORGANIZATION NAME AND ADDRESS Planning and Management Consultants Ltd. Post Office Box 927 Carbondale, Illinois 62901		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS U.S. Army Engr. Institute for Water Resources Kingman Building Fort Belvoir, Virginia 22060		12. REPORT DATE (11) April 1980
		13. NUMBER OF PAGES 73
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office)		15. SECURITY CLASS. (of this report) Unclassified
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Conservation, water supply, planning

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The report describes the concepts, procedures, and measurement techniques which can be used in developing and evaluating water conservation proposals applicable to municipal and industrial uses of water.

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

411356

SECURITY CLASSIFICATION OF THIS PAGE(*When Data Entered*)

SECURITY CLASSIFICATION OF THIS PAGE(*When Data Entered*)

THE EVALUATION OF WATER CONSERVATION FOR MUNICIPAL AND INDUSTRIAL WATER SUPPLY

PROCEDURES MANUAL

submitted to the:

U.S. ARMY ENGINEER INSTITUTE FOR WATER RESOURCES
KINGMAN BUILDING
FORT BELVOIR, VIRGINIA 22060

by:

Planning & Management Consultants, Ltd.
808 West Main
P.O. Box 927
Carbondale, Illinois 62901
(618) 549-2832

under:

Contract No: DACW72-79-C-0018

April 1980

PREFACE

During the decade of the 1970's, emphasis on environmental quality was paramount. Now, the role of conservation has begun to capture national prominence in resource planning and management. The U.S. Army Corps of Engineers recognizes the potential value of conservation and is making provisions for consideration of convervation in its water resources planning and management activities. This procedures manual is part of the preparatory work initiated a few years ago by the Corps of Engineers to adequately and fairly evaluate the conditions under which conservation should be implemented.

The first task, in the Corps of Engineers' preparatory work, resulted in the publication of An Annotated Bibliography of Water Conservation, which is a survey of available information on water conservation. Based on this information and experience, the following issues were raised:

(1) What is conservation?
(2) What is the effectiveness of known conservation measures?
(3) What are the principles for evaluating water conservation?

The second publication, The Role of Conservation in Water Supply Planning, addressed the above issues, as well as other issues. The concepts developed in the second publication have been translated into the detailed procedures shown in this manual. Two illustrative examples have also been developed to accompany this manual and to demonstrate its effective use by Corps of Engineers planners.

In every stage of development, this procedures manual benefitted from the constructive criticism of numerous persons. Special recognition, for their enthusistic and generous support to this process, is due the following Corps of Engineers personnel:

James Crews	William Pearson
Donald Duncan	William Porter
Kyle Schilling	H. W. Worthington

Additional valuable assistance was also provided by other Corps of Engineers personnel listed below:

George Baer	Ted Hillyer
Lawrence Bergen	William Johnson
Edward Cohn	Gary McMichael
John Cullinane	Robert Nordstrom
Edward Dickey	Stuart Piken
Dennis Duke	Edgar Story
C. T. Garvey	Daniel Sturman
Beverly Getzen	W. R. Summit
Vernon Hagen	Harry Walton
Robert Harrison	Richard Waugh

Finally, many aspects of the production of this manual would have been virtually impossible without the dedicated and capable contractor-support of the following persons:

Duane Baumann	Bonnie Kranzer
John Boland	Stan Leiber
Philip Carver	Pam Matlock
John Sims	Barbara Pearson
Kirk Alley	Jerry Reynolds
Nancy Baumann	Anne Sharpe
Dan Irwin	Neil Smith

Table of Contents

Table of Contents (Continued)

CHAPTER 1

INTRODUCTION

1-1. Purpose. This manual describes the concepts, procedures, and measurement techniques which can be used in developing and evaluating water conservation proposals applicable to municipal and industrial uses of water. Water conservation proposals, along with water supply augmentation schemes, serve to reduce the gap between future water demand and future water supply. The water supply purpose of a water resource development project, therefore, can be achieved by water supply augmentation, by water conservation, or by some combination of both approaches.

This manual addresses the water conservation element of the water supply/conservation plan, and is intended to supplement existing procedures (including 14 Dec. 79 WRC Procedures Manual) devoted to the development and evaluation of water supply plans. A balanced approach is intended, where both the benefits and the costs of water conservation measures are considered according to the same principles, standards, and criteria employed for other aspects of water resource development planning.

1-2. Need for Water Conservation Studies. Water is a basic requirement for human survival, is necessary for economic growth and prosperity, and is fundamental to protecting the natural environment. There is remarkable diversity in the role of water across this country. Given the diversity, national standards or dictated water use patterns for the country are not feasible. In addition, federal studies are not intended to preempt the primary responsibility of the states for water management and allocation. New supply will still be necessary. On the other hand, using existing supplies more efficiently is often cheaper and less damaging to the environment than developing additional supplies. This manual provides an evaluation process that will permit a consistent and balanced approach to determining trade-offs between water conservation and increments of new water supply. The emphasis is on municipal and industrial water supply recognizing that scope and authority of Corps of Engineers studies does not generally require detailed analysis of other water uses. When the impact of those uses on the regional water supply directly affects the evaluation of conservation for municipal and industrial water systems, coordination may be undertaken with others having the primary responsibility for such conservation.

1-3. Relationship of Water Conservation to Water Supply Planning. This guidance is intended to assist in producing study results that balance demand management and new supply within the planning framework of the Principles and Standards. Water conservation should not be viewed as a new planning function similar to flood control and navigation, but should be viewed as an integral part of what has traditionally been identified as municipal and industrial water supply. The evaluation of the adequacy of existing supplies and the measures needed to address future water needs requires an assessment of:

- The merits of demand reduction practices;
- The potential for more efficient utilization of existing supplies; and,
- The need for new supplies.

The first two categories are included within the definition of water conservation. This manual attempts to provide a common basis for evaluating water conservation and new supply measures. Otherwise, water conservation becomes a subjective part of planning to be argued without common terms of reference.

1-4. Definitions.

ACCEPTABLE MEASURE -- A water conservation measure for which there is no known obstacle to implementation.

BASE YEAR -- The earliest year in which implementation of any water conservation measure under consideration would begin; or any earlier year, which may correspond to the base year used in the water supply plan of which water conservation is to be a part.

BENEFICIAL REDUCTION -- A reduction in water use (or water losses) which creates net advantageous effects which exceed the net disadvantageous effects required by the actions which accomplished the reduction.

CONTINGENT WATER CONSERVATION MEASURES -- Measures which are implemented only under prespecified circumstances, and then only for a limited time span. Such measures are basically crisis oriented, and are capable of rapid implementation.

DISAGGREGATE WATER USE -- Community water use stated separately for each user class or sector. Seasonal water uses may also be stated separately from nonseasonal uses.

FEDERAL PLAN -- The federal plan may be either a water supply plan, or a water supply/conservation plan.

Water Supply Plan -- Refers to the measures included in the NED, EQ and other plans (as formulated without consideration of additional water conservation measures) to satisfy future water needs. The water supply plan may be a single purpose plan, or it may be the water supply element of a multi-purpose plan.

Water Supply/Conservation Plan -- Refers to a water supply plan modified to include a water conservation proposal. The water conservation proposal should be formulated to provide a net positive contribution to the objective served by the water supply plan.

LONG TERM WATER CONSERVATION MEASURES -- Measures which, once implemented, remain continuously in effect throughout the remainder of the planning period.

NONSEASONAL WATER USE -- Those water uses which are presumed invariant throughout the year; the minimum level of water use experienced during a year.

PLANNING AREA -- The geographical area containing those water uses which are the subject of water conservation planning.

PLANNING PERIOD -- The period of time, beginning with the base year, for which benefits and costs attributable to water conservation measures will be identified and measured.

POTENTIALLY ACCEPTABLE MEASURE -- A water conservation measure for which there is some obstacle to implementation (technical, social, political, institutional, etc.); but the obstacle is either one which is reasonably likely to disappear at some future time, or one which is substantially within the power of the affected community to remove.

SEASONAL WATER USE -- The difference between total annual water use and total nonseasonal water use; those water uses which are expected to vary with season.

TIME HORIZON -- The last year of the planning period; also, the length of the planning period.

UNACCEPTABLE MEASURE -- A water conservation measure for which there is some obstacle to implementation (technical, social, political, institutional, etc.); furthermore, the obstacle is one which cannot be reasonably expected to disappear at a future time, and which is not substantially within the power of the affected community to remove.

WATER CONSERVATION -- Any beneficial reduction in water use or water losses.

WATER CONSERVATION MEASURE -- Any act, regulation, incentive, or practice which conserves a given supply of water through a beneficial reduction in water use (or losses).

WATER CONSERVATION PROPOSAL -- One or more water conservation measures intended for implementation in a given planning area, the aggregate effect of which is a beneficial reduction in water use (and/or losses).

WATER LOSS -- Water which, having once been defined as part of supply, is no longer available for use.

WATER SUPPLY -- The quantity of water, at a particular time and place, which is available for use.

WATER SUPPLY PLAN -- see "federal plan."

WATER SUPPLY/CONSERVATION PLAN -- see "federal plan."

WATER USE -- Water intentionally withdrawn, diverted, or physically segregated from supply so that it is temporarily or permanently unavailable for other purposes.

WATER USER CLASS OR SECTOR -- A grouping of individual water users expected to display similar use characteristics; for example, residential users, commercial users, etc.

CHAPTER 2

GENERAL APPROACH TO WATER CONSERVATION PLANNING

2-1. Definition and Description of Water Conservation. Future water needs will be met by:

(1) Providing new supplies

(2) Achieving more efficient utilization of existing supplies

(3) Achieving reduction in water use.

Previously, water supply planning has addressed only the first category, supply augmentation strategies. The efficiency of utilization of existing supplies and future levels of water use have been taken as given. A more comprehensive approach to water supply planning requires consideration of measures which may improve the efficiency of utilization of existing supplies (measures which reduce water losses) and which may reduce future levels of water use. These measures are collectively termed water conservation measures.

Water conservation is defined as any beneficial reduction in water use or in water losses. A water conservation measure is a practice or action which meets the following tests:

(1) Implementation of the measure results in water use (or water loss) which is, at some time, less than it would have been had the measure not been implemented (with/without comparison). This reduction in water use conserves supply, making some portion of existing or future supply available for uses which would not have otherwise been served.

(2) The water use reduction is beneficial. Implementation of the measure must produce a net positive contribution to the National Economic Development (NED) objective, or the Environmental Quality (EQ) objective, or both. This requirement insures that the water conservation measure is consistent with conservation of all scarce resources.

Good water management requires the use of all beneficial practices, whether they affect supply or demand. This separate discussion of water conservation recognizes certain unique problems which arise in planning measures which are typically not directly implementable by the Corps, and which have not been routinely included in water supply planning.

a. Water Conservation Measures. Water conservation measures are demand management strategies: they affect the level and nature of the use of water, they do not affect the supply of water. Any specific management action which conserves a given supply through reduction in water use (or in water loss), and which results in a net increase in social welfare (is beneficial), is a water conservation measure. Social welfare is increased by beneficial effects on the NED or the EQ objective; it is decreased by adverse effects on either objective. Specific water conservation measures may be classified as (1) regulatory practices, (2) management practices, or (3) education efforts.

Regulatory practices include all measures taken in response to local, state, or federal legislation. For example, an industrial user's decision to increase water recycling in response to incentives created by National Pollutant Discharge Elimination System permit requirements, as issued in compliance with Public Law 92-500, would qualify as a water conservation measure undertaken in response to regulation. Local codes and ordinances would also apply, such as requirements for the use of water-saving toilets and reduced-flow shower nozzles in new housing units, or requirements to retrofit water-saving plumbing fixtures in selected existing housing. In general, any regulations or restrictions which carry penalties or sanctions for noncompliance such as sprinkling restrictions or water rationing (when enforceable by civil penalty or by disconnection), are included under regulation.

Management practices are actions taken by responsible units of local government, or by water suppliers, which result in beneficial reductions in water use or water losses, either directly or through the incentives which these actions create for water users. This category of water conservation measure includes leak detection and repair programs, reduced water use for public purposes, conservation-motivated metering and pricing programs (rate reform).

Educational efforts are water conservation measures when they result in voluntary reductions in water use within the context of existing legal and economic incentives. For example, providing information on efficient techniques for residential lawn and garden irrigation may result in lower water use for this purpose, all other factors including weather and price being equal. Educational efforts may elicit public support for a water use reduction program, stimulating voluntary conservation actions on the part of individuals, without altering specific economic incentives.

b. Water Conservation Proposals. Water conservation measures which address actual or anticipated water uses in a given planning area are said to be applicable water conservation measures. Those applicable measures which are not precluded from implementation for some compelling reason are acceptable, or potentially acceptable measures. A water conservation proposal is one set of one or more acceptable (or potentially acceptable) water conservation measure(s) intended for implementation in the planning area. As in the case of individual measures, the proposal must be applicable to the planning area, it must be acceptable (or potentially acceptable), and it must be beneficial.

Individual water conservation measures can be combined to yield many different water conservation proposals. These water conservation proposals, in turn, comprise alternative elements in a water supply/conservation plan. Alternative plan configurations imply the existence of alternate water conservation elements. For example, a water conservation proposal may be developed to be consistent with the National Economic Development (NED) plan; another water conservation proposal may be appropriate to the Environmental Quality (EQ) plan. In the first case, the water conservation proposal would seek to realize the largest net NED benefit; the second water conservation proposal would be the one which makes the largest contribution to the EQ objective. Other alternative plans, reflecting significant tradeoffs between the NED and EQ objectives may be formulated. For each such plan, a water conservation proposal which reflects the same tradeoffs between objectives can also be formulated.

2-2. General Procedure. This manual assumes that future water supply needs as well as alternative plans for providing for those needs have been established in accordance with existing procedures for the development and evaluation of water supply plans. These alternative plans include water conservation measures only to the extent that they may be already implemented or scheduled for implementation (included in the without project condition). Water conservation measures not already implemented or scheduled for implementation are the basis of development of alternative water conservation proposals. Water conservation proposals are tested to determine whether water supply plans can be improved by inclusion of a water conservation element.

The proposals include both advantageous and disadvantageous effects. Postponement or avoidance of costs associated with new supply facilities (reducing adverse effects for the water supply plan) is one source of advantageous effects for water conservation proposals. In addition, anticipated local costs of wastewater treatment may be postponed or avoided, and certain energy costs may be avoided (beneficial effects resulting from external economies). Disadvantageous effects of water conservation include implementation costs (adverse economic effects) and reductions in outputs for other project purposes, such as recreation, resulting from project downsizing foregone beneficial effects).

The evaluation procedure is summarized in Figure 2-1. Water supply plans are formulated according to existing procedures, without consideration of additional water conservation measures. The potential water conservation measures are identified by the measure-specific analysis; these individual water conservation measures then are evaluated against the alternative water supply plans. Based on this evaluation, water conservation proposals are developed, which can be integrated into water supply plans, yielding alternative water supply/conservation plans.

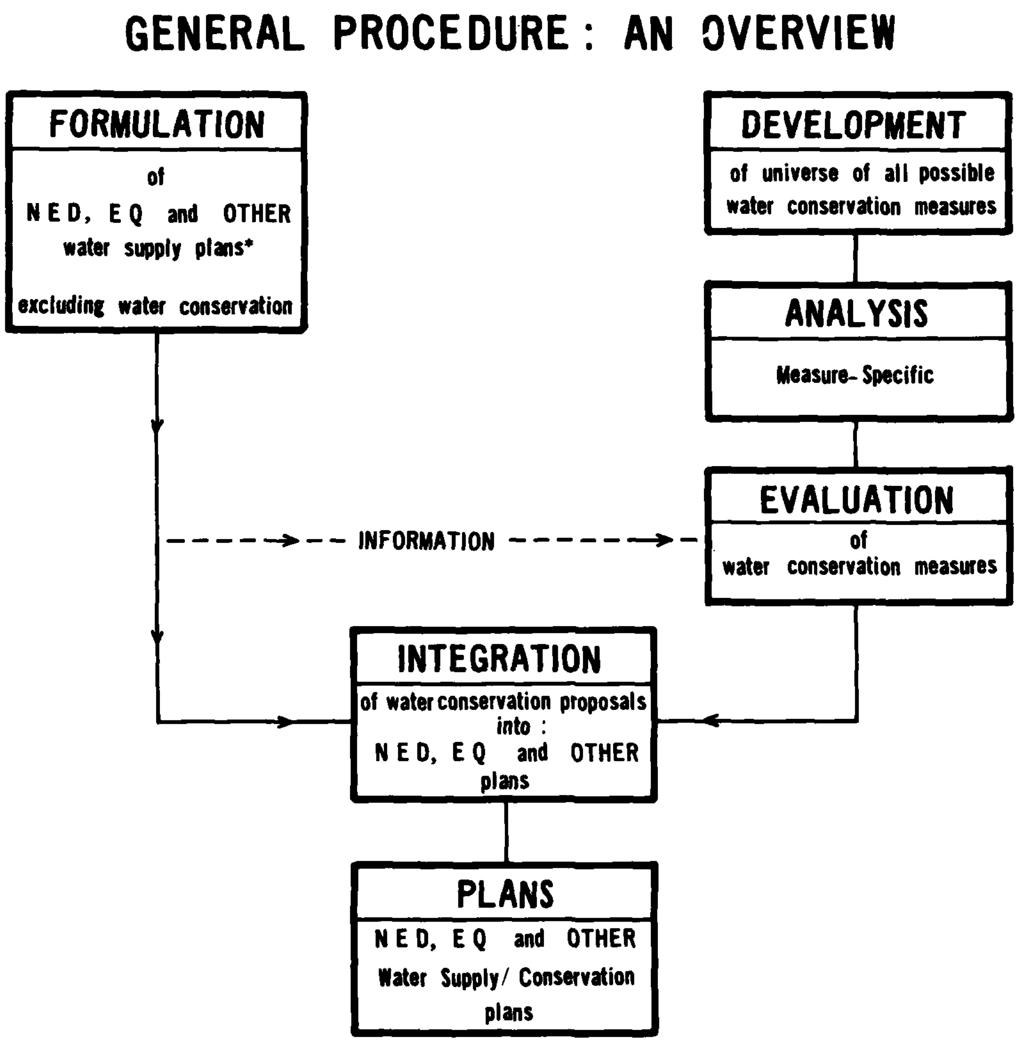


FIGURE 2-1

* Water supply plans may also be the water supply portion of a multi-purpose plan.

The manual should prove useful in the evaluation of water conservation proposals, but it does not attempt to describe all possible measurement techniques. Proposals for new supply must be paired with justified (Principles and Standards context) measures for the efficient use of existing supplies. The complexity of water conservation studies will vary based on the circumstances of each case. Judgment will be required in the application of these procedures. It is not intended that complex and expensive studies be made of water conservation measures that produce small increments of water savings. The studies of water conservation measures should, however, be commensurate with the magnitude of potential water savings and their potential impact on supply alternatives.

2-3. Evaluation Criteria.

a. General. Advantageous and disadvantageous effects of water conservation measures are identified and measured by comparing conditions expected to exist in the presence of the water conservation measure with those expected to exist in its absence, assuming the implementation of a specific federal water supply plan. Unless otherwise specified in this procedure, all standards of evaluation are those given in the Principles and Standards.

Where water conservation measures are already implemented, or definitely scheduled for implementation, these specific measures are not considered in the development of alternative water conservation proposals. Instead, they are a part of the "without project condition," the basis of development and evaluation of the alternative water supply plans. Water use forecasts must take account of the existence of already implemented or about-to-be-implemented water conservation measures. Similarly, analysis and evaluation of water conservation measures considered for integration in the federal plan must take account of possible interactions with measures included in the "without project condition."

b. Base Year Definition. For purposes of evaluating water conservation measures, the base year is the first year in which implementation of any measure is planned to begin; or it may be an earlier year corresponding to the base year for the federal plan.

c. Period of Analysis. Where the water conservation measure is being considered for integration into a federal water supply/conservation plan, the period of analysis will be the period beginning in the water conservation base year, and ending at the end of the period of analysis chosen for the federal plan. Otherwise, the period of analysis will be taken as 50 years from the base year.

d. Amortization. All economic advantageous and disadvantageous effects will be brought to present worth as of the base year, then amortized over the period of analysis, using the discount rate as published annually by the Water Resources Council.

e. Price Levels. Economic advantageous and disadvantageous effects shall be evaluated under prices existing at the time the report is completed.

2-4. Measurement of Disadvantageous Effects. Disadvantageous effects associated with water conservation measures or water conservation proposals include, but are not limited to, implementation costs, whether borne by water suppliers or by water users; lost water user benefits; lost benefits to users of other services of a multi-purpose project; and external diseconomies including adverse environmental effects.

a. Implementation Costs. Water suppliers or responsible local government agencies may incur incremental costs due to the promulgation and enforcement of codes, regulations, or restrictions; the development of leak detection and repair programs; the development and implementation of metering and pricing alternatives; or the dissemination of educational information. Water users may incur incremental costs as a result of differential costs for water-saving plumbing fixtures; increased life-cycle costs due to accelerated replacement of existing plumbing fixtures; installation and operation of water recycle facilities; or installation and operation of auxiliary water use equipment (timers, soil moisture sensors, etc.). In every case, disadvantageous effects are measured as incremental implementation costs, comparing the with water conservation condition to the without water conservation condition.

b. Lost Water User Benefits. Where mandatory restrictions are placed on water use -- whether by local ordinance, by regulations adopted pursuant to authorizing legislation, or by restrictions imposed by the water supplier -- water users are required to forego uses for which they would be willing and able to pay. Disadvantageous effects are measured as the amount water users would be willing to pay for the water used without restrictions, less the amount users would be willing to pay for the water used in the presence of the restrictions.

c. Lost Benefits to Other Purposes. Implementation of water conservation measures can be expected to result in postponement and/or downsizing of planned water supply facilities. Where those facilities are a part of a multi-purpose water resource development project, other services to be provided by the project (such as recreation services, flood control services, hydroelectric energy, etc.) may also be postponed or downsized. Lost beneficial project effects attributable to this cause are disadvantageous effects of water conservation.

d. External Diseconomies. Where water conservation measures result in changes in the appearance of lawns, gardens, parks, etc., or where they interfere with the normal operation of decorative fountains, recreational facilities, etc., disadvantageous effects on visual and recreational amenities may be measurable. Disadvantageous effects may appear for persons other than the water conserver, due to decreased property values, reduced wastewater flows to subsequent users, etc. These and other possible disadvantageous effects, whether affecting the NED or EQ objective, must be identified and measured or described.

2-5. Measurement of Advantageous Effects. The advantageous effects of water conservation derive principally from the foregone use of existing and planned water supply facilities, as well as the reduced withdrawal of water from natural water courses or reservoirs. Specific advantageous effects may appear as foregone supply costs (either short run or long run) affecting the federal plan, or locally planned facilities, or both; or as external economies or foregone external diseconomies.

a. Foregone Supply Costs. Incremental costs of water supply, transmission treatment, storage, and distribution which can be foregone as a direct consequence of conservation-induced reductions in water use or water losses constitute advantageous effects of water conservation.

(1) Federal Plan Costs. Implementation of water conservation may reduce the cost of constructing and operating water supply facilities included in the federal plan. The reduction may occur because of downsizing or reconfiguration of the federal plan, or by postponing the implementation of all or a part of the federal plan.

(a) Long Run Supply Costs. Construction costs of federally planned water supply, transmission, treatment, storage, and distribution facilities are long run supply costs. Implementation of water conservation will have the effect of reducing the requirement for water supply capacity throughout the planning period, compared to what it would have been in the absence of conservation. The resultant reduction in the present value (or annualized value) of the construction costs is an advantageous effect of water conservation.

(b) Short Run Supply Costs. Water that is not used is water that need not be pumped, treated, stored, or distributed. To the extent that operating and maintenance costs are included as adverse effects in the federal plan, implementation of water conservation will result in incremental reductions in those costs, an advantageous effect on water conservation.

(2) Other Supply Costs. In addition to facilities included in the federal plan, other water supply facilities may be required to serve the affected communities throughout the planning period. These include facilities already existing, facilities under construction or authorized and likely to be constructed, and facilities which will be required in the future. Implementation of water conservation may result in incremental reductions in the future costs of constructing and operating these facilities.

(a) Long Run Supply Costs. Construction costs of locally planned water supply, transmission, treatment, storage, and distribution facilities are long run supply costs. Conservation-induced reduction in the present value (or annualized value) of these construction costs is an advantageous effect of water conservation.

(b) Short Run Supply Costs. Conservation-induced reduction in the cost of operating and maintaining existing and locally planned facilities is an advantageous effect of water conservation. Other short run costs to be included here are reductions in the costs of operating and maintaining federally planned facilities, to the extent that such costs are not included in the federal plan.

b. External Economies. Reductions in water use or water losses may create beneficial effects for individuals or organizations other than the water supplier or water users. These beneficial effects may include economic (NED) benefits as well as beneficial environmental (EQ) effects, and are advantageous effects of water conservation.

(1) Economic Benefits. Reductions in water withdrawals may allow competing water users to capture economic benefits (increase value of outputs of goods and services) not otherwise available to them. These benefits may result from increased hydropower output, increased recreational activity, increased agricultural output, etc.

(2) Beneficial Environmental Effects. Such environmental effects as improved reservoir appearance (reduced drawdown), increased flowby during times of critically low streamflow, etc., are advantageous effects of water conservation.

c. Foregone External Diseconomies. Reductions in water use or water losses may result in avoidance of certain adverse effects due to external diseconomies. These foregone external diseconomies are advantageous effects of water conservation, and may include foregone economic (NED) costs as well as foregone adverse environmental (EQ) effects.

(1) Foregone Economic Costs. Reduced water withdrawals may result in certain costs being avoided, such as pumping costs incurred by competing users of groundwater aquifers, etc.

(2) Foregone Adverse Environmental Effects. Where adverse environmental effects are avoided or reduced as a consequence of water conservation (such as reduced land subsidence from groundwater overdrafts), these foregone adverse effects are advantageous effects of water conservation.

2-6. Evaluation of Water Conservation Proposals. Water conservation proposals are evaluated with respect to the NED and the EQ objectives. Advantageous effects and disadvantageous effects with respect to each objective are determined. Special attention must be given to those cases where the advantageous or disadvantageous effects of a water conservation proposal differ from the sum of effects for individual measures (interactions). For each alternative water supply plan, a water conservation proposal is developed which makes the maximum contribution to the objective, or combination of objectives, used to develop that plan.

a. NED Plans. The water conservation proposal which, when evaluated under NED water supply plan conditions, makes the largest net contribution to the NED objective should be integrated into the NED water supply plan to yield the NED water supply/conservation plan. Because of possible interactions among measures, individual water conservation measures must be substituted for increments of supply in decreasing NED merit order until no further increases in net beneficial impact occur.

b. EQ Plans. The water conservation proposal which, when evaluated under EQ water supply plan conditions, makes the largest net contribution to the EQ objective should be integrated into the EQ water supply plan to yield the EQ water supply/conservation plan. Because of possible interactions among measures, individual water conservation measures must be substituted for increments of supply in decreasing EQ merit order until no further increases in net beneficial impact appear.

c. Other Plans. As provided in the Principles and Standards, other plans which reflect significant tradeoffs between the NED and the EQ objectives can be developed. The water conservation proposal which, when evaluated under conditions corresponding to the other water supply plan, makes the largest net contribution to the combination of objectives in formulating the other plan should be integrated into that plan, yielding an alternative water supply/conservation plan. Because of possible interactions among measures, individual water conservation measures must be substituted for increments of supply in decreasing merit order until no further increases in net beneficial impact occur. In this case, merit order and net beneficial impact both refer to the combination of objectives employed in formulating the alternative water supply plan. In some cases, other plans will include water supply plans formulated to maximize the net contribution to a single objective, either NED or EQ, except that other project purposes (for example, flood control) may be satisfied by nonstructural means. In this case, the evaluation of water conservation measures and their integration into the plan will proceed as for NED or EQ plans, respectively.

2-7. Primarily Nonstructural Plans. Revisions to the Principles and Standards published in 14 December 1979 include the following statements:

> In addition, at least one primarily nonstructural plan will be prepared and included as one alternative whenever structural project or program alternatives are considered. (44 Fed. Reg. 72979, 14 December 1979)
>
> A "primarily nonstructural plan" is an alternative plan which makes maximum feasible use of nonstructural measures as a means of addressing water resources problems and needs. (44 Fed. Reg. 72987, 14 December 1979)

This requirement with respect to the water supply/conservation purpose will be satisfied when water conservation has been integrated into the NED, EQ, and other plans as outlined in the preceding paragraphs.

CHAPTER 3

WATER CONSERVATION MEASURES

3-1. Classification Scheme. Water conservation measures can be placed into three major classes according to the originating action; those water conservation measures resulting from (1) regulatory actions, (2) management actions, and (3) education efforts. Each category includes many possible conservation measures. Since some measures have more than one origin, the categories are not necessarily mutually exclusive. A water conservation proposal may encompass measures from all three major classes of alternatives, or it may be confined to one or a few measures from a single major water conservation class.

a. Regulation. Water conservation measures are attributed to regulation when they are direct or indirect responses to specific federal and state laws, policies, local codes, ordinances or restrictions. Specific actions may be mandated by law or regulation, or they may be taken in response to incentives created by law or regulation. These would include, for example, such measures as those taken in order to comply with the Clean Water Act Amendments, Presidential directives to federal agencies, municipal plumbing codes or water rationing programs. The measures would all entail a specific technological or behavioral change which must either serve as a prerequisite for further action or monies, as in the case of the Clean Water Act Amendments requiring wastewater flow reductions, or be subject to penalties or sanctions for noncompliance.

b. Management. Some water conservation measures originate in management actions taken by the water supplier itself. When individual water users conserve water as a result of management measures, they do so in response to economic incentives, which the management actions create, not through threat of sanction. Metering and pricing strategies, leak detection programs and tax incentives all fall into this class. Reductions in water used for public purposes also qualify as management actions.

c. Education. The education class of water conservation measures provides a third set of alternatives which can be implemented by many types of government agency, public body, or public interest group including the water supplier itself. Media such as direct mail, radio, television, newspapers, billboards, etc., are used to encourage and facilitate voluntary changes in water use habits and water use technology. The measures themselves can range from a general voluntary conservation campaign to a voluntary campaign aimed at a specific goal or problem, such as residential water use at peak periods.

3-2. Long Term vs. Contingent Measures. Water conservation proposals may include long term conservation measures, contingent measures, or both. Both types of measures fall into the same categories, and include the same types of actions and responses. Long term measures are implemented once and remain in effect for the remainder of the planning period. Even though in effect continuously, they may be intermittent in actual application, such as restrictions on seasonal sprinkling uses. Contingent measures differ from long term measures in that they are limited to a particular time span, are usually crisis oriented, are rapidly mobilized, and are employed only under prespecified circumstances. The contingent measures may be similar to any of the long term measures but may be applied for a shorter duration and with greater emphasis depending on the local situations. Therefore, certain contingent measures such as rationing during periods of droughts differ from corresponding long term measures only in duration, focus and intensity.

3-3. Typical Water Conservation Measures. An illustrative list of water conservation measures appears as Table 3-1. While other conservation measures may be suggested, the general headings shown on this table embrace most specific measures commonly proposed.

Water conservation measures can be applied to all water uses, or to specific major water uses such as residential water use, either in-home or outdoors, industrial water use or commercial water use. Particular water conservation actions are more appropriate to some major uses than others in terms of effectiveness and feasibility. For example, a plumbing code alteration may require the installation of fixtures in the home that would reduce water use. Devices such as pressure-reducing valves, faucet aerators, water-saving toilets, flow-limiting faucets and showerheads would then be installed. Such devices at the industrial level may not prove effective while the adoption of a water reuse scheme or recycling process may be more suitable and economically justifiable.

The domain of choices remains constant for all water uses but considerations of applicability, feasibility, and effectiveness are more specific. Examples of specific water conservation measures are (1) a plumbing code that requires the installation of a low flush toilet (3.5 gallons) and a showerhead flow control of 3 gallons per minute (gpm) in all new residential units, reducing residential in-home water use; (2) community-wide distribution of water saving kits and information pamphlets aimed at reducing water use by all user classes; (3) the introduction of marginal cost pricing for all water users; (4) leak detection programs in suburban residential areas; (5) a televised educational campaign encouraging repair of leaks; and (6) a sprinkling ordinance requiring homeowners to water their lawns only on alternate days between 8 p.m. and 10 a.m.

TABLE 3-1

ILLUSTRATIVE LIST OF WATER CONSERVATION MEASURES

REGULATIONS	MANAGEMENT	EDUCATION
Federal and State Laws and Policies A. Presidential Policy B. PL 92-500 C. Clean Water Act Amendment 1977 D. Safe Drinking Water Act Local Codes and Ordinances A. Plumbing Codes for New Structures B. Retrofitting C. Sprinkling Ordinances D. Changes in Landscape Design E. Water Recycling Restrictions A. Rationing 1. Fixed Allocation 2. Variable Percentage Plan 3. Per Capita Use 4. Prior Use Basis B. Determination of Water Use Priorities 1. Restrictions on Public and Private Recreational Uses 2. Restrictions on Commercial and Institutional Uses 3. Car Wash Restrictions	A. Leak Detection B. Rate Making Policies 1. Metering 2. Pricing Policies a. Marginal Cost Pricing b. Increasing Block Rate c. Peakload Pricing d. Seasonal Pricing e. Summer Surcharge f. Excess Use Charge C. Tax Incentives and Subsidies	A. Direct Mail B. News Media C. Personal Contact -Speaker Program D. Special Events -School Programs

In order to minimize analytical effort, initial consideration should be given to measures defined in relatively general terms (such as in Table 3-1). Measures can be defined more narrowly, or subdivided into several even more narrowly defined measures as the analysis proceeds, but only as necessary. For example, consideration may be given to the use of an increasing block rate structure. It may be determined, in assessing applicability, that only a rate structure containing separate rates for industrial and nonindustrial customers would be appropriate to the community. Analysis of social acceptability issues may reveal that only increasing block structures which do not appear to discriminate against large families would be acceptable. Effectiveness analysis may rule out some rate designs as not effective in reducing water use. Each step in the analysis produces a more narrowly defined measure, until a very specific rate-making option emerges as the final conservation measure. The important point is that detail is added only as needed, so that the total amount of detail is minimized throughout.

CHAPTER 4

MEASURE-SPECIFIC ANALYSIS

4-1. Overview. Measure-specific analysis consists of the identification of possible water conservation measures and all steps in the evaluation which do not require knowledge of the costs and characteristics of the water supply plan. Measure-specific analysis is outlined in Figure 4-1. It begins with the selection of those water conservation measures which appear to be applicable to the study area. Investigation of the social acceptability of these measures may result in discarding some as unacceptable; in more narrowly defining others to avoid unacceptable aspects; or in labelling other measures as potentially acceptable pending some future change in attitudes, legislation, or institutions. The resulting list of potential water conservation measures is subjected to further analysis to determine implementation conditions, effectiveness, and certain advantageous and disadvantageous effects (those unrelated to or indirectly related to water use reductions). These steps are described in the following paragraphs.

4-2. Prerequisites to Analysis. The following provides a description of those considerations common to measure-specific analysis of all water conservation measures.

a. Description of Water Conservation Measures. Each water conservation measure to be considered must be enumerated. Descriptions will be initially stated in general terms, but will acquire detail as the analysis progresses. Ultimately, each description must indicate what action is to be taken, what agency or group is to take the action, what class of water use is to be affected, and whether the measure is to be implemented on a long term or a contingent basis.

b. Disaggregated Water Demand Forecasts. Forecasts of water use, disaggregated by user sector and season, should be available for the period of analysis. Disaggregation is important for making estimates of the effectiveness of water conservation measures which affect specific types of water use. Water use should be forecasted separately for the following sectors: residential (include indoor uses and outdoor uses such as lawn irrigation and car washing); commercial (include water use for retail and wholesale trade, offices, hospitals, schools, medical laboratories, restaurants, service industries, etc.); industrial (including all water used by manufacturing industries as an input to production processes); and additional uses (include public service use -- for example, fire protection -- and unaccounted-for water). Where possible, further disaggregation should be employed -- for example, residential use may be divided into inside and outside components, industrial use may be divided into process water and nonprocess water. Also, water use should be forecasted separately by season (for

MEASURE – SPECIFIC ANALYSIS

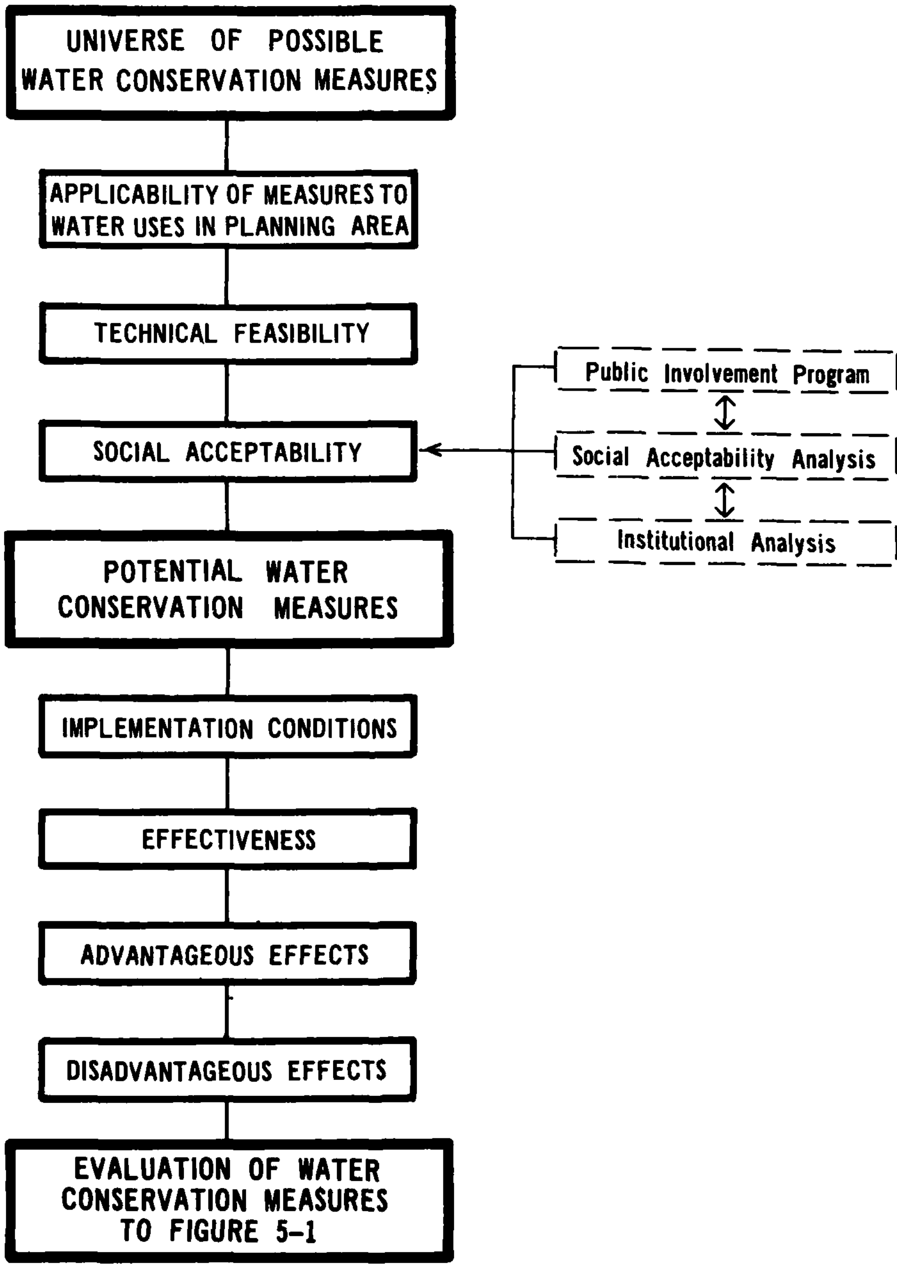


FIGURE 4-1

example, summer vs. winter), either in aggregate or, preferably, by sector. Where disaggregated forecasts are not used, estimates of effectiveness and of beneficial effects may include substantial error.

4-3. Applicability. Applicable water conservation measures meet the following tests:

(1) They address water uses which occur, or are expected to occur in the planning area;

(2) They have not already been fully implemented throughout the planning area; and

(3) Definite commitments for future implementation throughout the planning area have not been made.

Where a measure is already implemented for a portion of the planning area, or for some (but not all) water uses within the area, the corresponding applicable measure is one which would apply to that portion of the planning area or to those water uses not now affected.

A list should be prepared of all applicable water conservation measures. The list should appear in the final study report, and form the initial array of potential water conservation measures. A separate list should be prepared of those water conservation measures found to be already implemented, or planned for future implementation, so that inclusion of these measures in the without project condition can be verified.

4-4. Technical Feasibility. Measures are technically feasible if, when implemented, they result in measurable reduction in the quantity of water used at some time. Engineering analysis and reports of field studies by others may be used to establish apparent technical feasibility. Technically infeasible measures should be removed from the list of potential water conservation measures. The final study report should show which measures were removed, and the basis for the determination of technical infeasibility.

Some measures may be potentially technically infeasible: they may be feasible only under certain conditions. Such measures should be retained for further analysis. In some cases, preliminary field tests of specific measures to test technical feasibility under prevailing conditions may be possible. Attention should be given to the possibility of changed conditions making feasible in the future a measure which may appear infeasible at the present. It is important that measures not be prematurely discarded on grounds of feasibility.

Examples of determinations of technical feasibility are:

(1) Field tests of devices for reducing toilet flushing volumes (plastic dams) may reveal that, for some types

toilets, flushing efficiency is so reduced that double- and triple-flushing occurs. A survey of the types of toilets in use may lead to the determination that general installation of the devices would not reduce, or may even increase, total water use.

(2) An analysis of local lawn and garden irrigation practices may show that restricting sprinkling to alternate days would not reduce water use by any measurable amount.

(3) Present technology for treating wastewater may not be considered sufficiently effective and/or reliable to support recycling wastewater for municipal reuse.

4-5. Social Acceptability. Acceptability is one of the tests required by the Principle and Standards in the formulation of alternative plans. Measures are socially acceptable if they would be adopted by the community in which they are proposed. Unlike technical feasibility or economic feasibility, however, it is only rarely that the social acceptability of a given water conservation measure can be predicted with certainty. Thus, it must be stressed that the goal of determining the social acceptability of a particular conservation measure should not be seen as the reaching of a clear yes or no decision; rather, the goal is to increase the quality of the judgment made as to what the probable response of the various sectors of the community to a proposed measure will be.

A community judges a measure to be acceptable if it is congruent with what may be termed its "social ideology," that is, with that constallation of values, attitudes, beliefs and feelings that define a community's commitment to a way of life. Making a judgment then, on the relative social acceptability of a conservation measure requires the measurement of social ideologies.

It should be recognized that the measurement of those community attitudes, beliefs, and feelings of relevance to water conservation is at best a matter of approximation. Fortunately, precision is not required, even a general outline of a community's social ideology is invaluable in aiding the prediction of community response to conservation measures.

Relationship of Social Acceptability to Public Involvement and Institutional Analysis. The methodology designed to measure the social acceptability of each water conservation measure can draw upon information that likely would be available from a water supply study's public involvement program and institutional analysis; and, in the process, the social acceptability methodology would provide additional information and insights to the on-going public involvement program and institutional analysis (see Measure-Specific Analysis, Fig. 4-1). It is important to remember the objective of the social evaluation of conservation measures and where public involvement and institutional studies can contribute to that objective. For example, the initial identification of issues and advisors may be information readily available from the overall public involvement program. Moreover, additional data on social acceptability may be obtained from interviews undertaken in a particular institutional study or from the completion of questionnaires at public meetings or workshops. The traditional public involvement program is not a substitute for the study of social acceptability described in this manual: it has a specific objective and therefore requires its own methodology. However, the public involvement program can contribute significantly, as can an institutional analysis study, to the process of achieving this objective.

What follows is an outline defining the steps of a method designed to measure social ideology in order to assess the social acceptance of conservation measures. The method described uses interviews with persons occupying positions of influence in both public and private institutions, and mail questionnaires with a random sample of the general public. It should be emphasized that social acceptability studies can be performed using other methods and other samples. Because some readers may be relatively unfamiliar with the concept of social ideology and its measurement, a considerably expanded discussion of each step of the method design delineated here is presented in Appendix A.

The goal of the method outlined below is to gain knowledge of those community values, attitudes, beliefs and feelings that might influence its receptivity to water conservation measures so that the decision as to whether a given measure should be proposed will be determined in part by an informed judgment as to probable community response.

Step 1: Initial Identification of Advisors. Based on their experience with the community, Corps personnel should select a group of "advisors," persons expertly familiar with the environmental and social issues of concern to the community (such as, land use policies or water rates), and with the interest groups associated with those issues (such as, a Chamber of Commerce or homeowners). It is likely that such knowledgeable persons are already engaged in Corps public involvement programs.

Step 2: Identification of Environmental Issues, Influential Individuals and Organizations. Open-ended, informal interviews are conducted with the community advisors to achieve two goals: first, to delineate the environmental and social issues of most relevance to the community; second, to identify specific individuals who represent various organizations or groups in the community who take positions on such issues. Again, the existing public involvement program, particularly Stage I, should be a significant source of information required in this step.

Step 3: Sample Selection and Instrument Design. The list of issues derived from Step 2 constitutes in part the content areas to be investigated in the study. In addition to such derived general issues, the study should explore response to those specific conservation measures that are of particular local relevance.

Response to these general and specific issues is to be obtained from two samples: one, the list of influential persons derived from Step 2 constitutes the target personal interview sample; two, a second sample, representative of the general public is drawn at random from the community population. This latter group constitutes the target mail questionnaire sample.

Two instruments must be designed. The first is an Interview Guide, to be used to direct the discussions held with those persons identified as representing various interests in the community. The questions should have two goals: first and foremost, to evoke responses that will illuminate those fundamental values, beliefs, attitudes and feelings that make up the ideological context within which any specific conservation measure proposed will be evaluated; and secondarily, to determine interest group response to specific conservation measures.

The second instrument designed is a mail questionnaire to be used in obtaining responses from the sample representing the general public. The questions here are limited to exploring public response to specific conservation measures.

Factors to be considered in instrument design are detailed in Appendix A. Appendix B is a copy of the mail questionnaire: five questions are asked for each conservation measure on which information is desired. The list may be expanded, depending upon the needs of the project and planning area as determined by Corps personnel.

Step 4: Data Collection. The logistics of conducting the data collection, by interview and by questionnaire, are presented in detail in Appendix A. In brief, interviews should be arranged to obtain the co-operation of the respondents sought, and conducted in ways which hold most promise to yield the data wanted. Similarly, the mail survey of the general public should be prepared in ways that encourage a high rate of return.

Step 5: Analysis of Data. The primary goal of the analysis of the interview data is the identification and delineation of the core or basic ideologies (values, attitudes, beliefs and feelings) that characterize the community. A subsidiary goal is the determination of interest group response to a range of specific conservation measures.

The goal of the analysis of the questionnaire data is the determination of the response of the unaligned general public to a range of specific conservation measures. Insights should be gained concerning the receptivity of specific measures of previously unknown groups of the public and the factors affecting their perception.

Analysis of data involves two processes -- first, the data must be ordered, abstracted, and statistically manipulated; second, it must be interpreted. A discussion of these processes is included in Appendix A.

Step 6: Determination of Social Acceptability. It will be recalled that the social acceptability of a conservation measure is determined by its congruence with the core or basic social ideologies that characterize a community and the distribution of information about each measure. To put it another way, a conservation measure will be socially acceptable if it does not violate those values, attitudes, beliefs and feelings that define a community's commitments. Thus, the purpose of the prior five steps outlined above is to scan the universe of community ideologies and bring into sharp focus those ideological factors of most relevance to conservation issues.

The remaining task, the determination of the social acceptance of given conservation measures, is accomplished by examining each in the light of the picture of community ideologies produced by the study. As each measure is reviewed, the data from the study will provide partial answers to such crucial questions as: who in the community would be for it, and why; what would it take to change opposition into support? These are the kind of final questions to be asked and which the study, if it cannot answer them definitively, can at least instruct.

In summary, then, the objectives of the measurement of the social acceptability of the conservation measures are:

(1) To provide information to assist in the formulation of *water conservation measures*; that is, to identify any initial social impediments to the implementation of specific water conservation measures. It is as important to learn, as supported with data, the absence of any social impediments as well as specific social obstacles to the public acceptance of specific water conservation measures. In this effort, insight will be gained concerning those ideologies most relevant to understanding a community's response to water conservation measures.

(2) To identify the information needs of the public (and sectors of the public) about specific water conservation measures. This information would likely be useful to the on-going public involvement program.

The steps involved in a study to determine the social acceptance of conservation measures have been briefly outlined. They are presented in schematic form in Figure 4-2.

4-6. Potential Water Conservation Measures. Following determination of social acceptability (or potential acceptability) for applicable water conservation measures, each measure can be defined more narrowly, or subdivided into several narrowly defined measures (see paragraph 3-3). Information obtained in the course of social acceptability analysis is used to formulate those measures least likely to encounter social impediments to implementation. The resulting acceptable (or potentially acceptable) measures are the potential water conservation measures.

THE MEASUREMENT OF SOCIAL ACCEPTABILITY OF CONSERVATION MEASURES *

STEP 1 INITIAL IDENTIFICATION OF ADVISORS

STEP 2 IDENTIFICATION OF ENVIRONMENTAL AND SOCIAL ISSUES, INFLUENTIAL INDIVIDUALS AND ORGANIZATIONS

Open–end general interview with advisors

STEP 3 SAMPLE SELECTION & INSTRUMENT DESIGN

(1) Advisors
- Select sample
- Design interview guide

(2) General public
- Select sample
- Design instrument

STEP 4 IMPLEMENTATION : DATA COLLECTION

(1) Advisors : the Interview

(2) General public : the Survey questionnaire

STEP 5 ANALYSIS OF DATA

(1) Advisors
- Ordering and abstracting of individual statements
- Interpretation

(2) General public
- Frequency distribution of responses
- Interpretation

STEP 6 DETERMINATION OF SOCIAL ACCEPTIBILITY

FIGURE 4–2

* See paragraph 4–5 noting that other methods to measure social acceptibility are available.

4-7. Implementation Conditions.

a. Coordination in Implementation Planning. The development of implementation plans for a water conservation program requires identification of the involved and related public and private agencies. Generally, a single agency or organization will maintain overall responsibility for implementation although several agencies may actually be involved in the process. In the public sector these may include federal, state and local government bodies. The configuration of agencies involved is not static but may change during the course of implementation, particularly if there is a clear distinction between different phases of implementation. This could arise, for example, if an initial phase involved the changes in physical infrastructure, and a subsequent phase involved only management or enforcement. Implementation will normally involve a variety of private groups, organized interests, and individuals as well as public bodies. Their roles and responsibilities must be carefully coordinated. Particular attention should be paid to planning the linkages between public and private groups, and between different groups in each sector.

Water conservation measures may be either mandatory (regulatory measures) or voluntary (management and education measures), and implementation plans will differ accordingly. With mandatory measures (such as legal restrictions on the quantity of water use, or technical restrictions on the types of plumbing fixtures that can be used) a greater variety of agencies, organizations and individuals can be expected to participate in the measure's implementation. Coordination at the planning stage is therefore important. Voluntary measures such as public information campaigns or the manipulation of water pricing systems, may involve fewer public agencies, but the active participation of private groups and individuals will be crucial. Mandatory measures are implemented in most cases by existing agencies and organizations. In the attempt to implement voluntary water conservation measures, the involvement of many interested private groups may be preferred.

b. Coverage and Duration. The expected coverage and duration of each water conservation measure must also be determined. The first decision to be made is whether conservation measures are to be long term (permanent) or contingent. Contingent measures require more careful planning and analysis. The agency responsible for implementation will determine the conditions under which contingent measures should be activated, and the expected period and frequency of implementation.

It will be necessary to define the areal coverage of measures, and whether they will be implemented throughout a contiguous region, or only at specified locales. Political boundaries such as those separating incorporated and unincorporated areas of an urbanized area may be important in this respect. Where existing political and institutional boundaries would lead to overly fragmented coverage, it may be necessary to investigate the possible role of regional or state agencies to facilitate implementation.

To spatial and temporal coverage can be added sectoral coverage. Some conservation measures, such as a leak detection program, may have quite general coverage regardless of whether it is residential, industrial or commercial use that is being considered. Other measures may be restricted to particular water use classes. Recycled wastewater, for example, is presently an unlikely alternative for domestic water usage.

Contingent measures tend to exhibit nearly instantaneous effects, while long term water conservation measures often require a longer implementation period. When the measure applies to new construction, or where extensive retrofitting is to be carried out, implementation will be gradual. In such cases, the responsible agency should prepare a completion schedule estimating the rate of implementation up to and including the period of full implementation.

4-8. Effectiveness. The effectiveness of a water conservation measure is defined as the reduction in water use which can be attributed to its implementation. The reduction is identified and measured on a with-without basis and is expressed as the average expected change in rate of use for each forecast year. Where the measure under consideration is a long term measure used intermittently, or a contingent measure, effectiveness must be further qualified with respect to the relevant time period. Because different kinds of water use are affected in different ways, the effectiveness for several definitions of use must also be specified. Among the definitions of use that may be affected are (1) average daily use; (2) maximum (peak) daily water use; (3) average daily sewer contribution; and (4) average daily consumptive use.

The following formula is used to obtain estimates of effectiveness.

$$E_{ijt} = Q_{jt} \cdot R_{ijt} \cdot C_{ijt}$$

where E_{ijt} = effectiveness of conservation measure i for use sector j at time t, in quantity per unit time (e.g., gallons per day).

Q_{jt} = predicted unrestricted water use in sector j at time t, in quantity per unit time (e.g., gallons per day).

R_{ijt} = fraction reduction in the use (or loss) of water for sector j, at time t, expected as a result of implementing measure i.

C_{ijt} = coverage of measure i in use sector j at time t, expressed as fraction of sectoral water use affected by conservation measure.

a. Predicting Unrestricted Use in Sector J (Q_{jt})

(1) Identification of Sectors of Water Use. The specific sectors chosen will depend on the data availability of the water supply agency being studied and the local circumstances. At a minimum residential, nonresidential, and public/unaccounted-for water uses should be separated. For residential and nonresidential sectors, uses which occur only during the peak seasons (seasonal use) should be separated from uses which occur year round (nonseasonal use). Seasonal use often includes uses which are relatively consumptive (irrigation of lawns, water-cooled air conditioners, evaporative coolers, etc.). These uses also contribute proportionally more to the total peak use than to total average use. A very high fraction of nonseasonal uses can usually be expected to be discharged into sewers. Care should be exercised in the classification of apartment uses. This use, which is primarily responsive to residential measures, is classified as commercial in many communities. Other potential sectors include commercial, industrial, metered public uses, agricultural, in-stream uses, and more detailed breakdowns of residential use by type of housing. Geographical disaggregation may also be useful in certain circumstances.

(2) Data Collection. Data item A in Table 4-1 provides the major source of information on water use. Where disaggregated billing data do not exist, preparation to assemble this data should begin as soon as possible. Individual customer accounts can be coded to indicate customer class, then disaggregate water use totals accumulated as each meter reading cycle is completed. Conducted in cooperation with local agencies that already have computerized billing operations, and using existing personnel, this process may require one to three years to produce a disaggregation of annual water use.

If time does not permit a more complete analysis, a shorter procedure may yield acceptable results for some communities. Under this procedure significant industrial users are separated manually, and the remaining water use is divided between residential and nonresidential categories according to meter size. Where disaggregate data already exist, the user class categories of the local agency will determine the sectors to be used in the estimation of effectiveness. Production data (item B) are used in combination with billing data to estimate water lost or unaccounted-for. Data items E and F, combined with discussions with local officials can sometimes be helpful in determining how much water is actually lost and how much is due to unmetered uses and meter misregistration.

Forecasts of water use by local agencies are seldom disaggregated by type of use. In these cases it will be necessary to prepare disaggregated forecasts, based on the disaggregated billing data, local agency water use projections, and other information. Where possible, sectoral water use should be projected as a function of the appropriate explanatory variables (residential in-house use as a function of number of households, population per household, family income, price, etc.). Care should be taken to either constrain the sum of the sectoral forecasts to equal the aggregate forecast, or to reconcile the two forecasts in some way.

TABLE 4-1

SAMPLE DATA REQUEST TO THE RELEVANT WATER AND SEWER AUTHORITIES

A. From water billing records:

1. Average water use per dwelling unit (or connection) for each billing month for each customer class for the past 5 years.
2. The number of connections for each customer class for the past 10 years.
3. The amount of water wholesaled (to other communities) for each month for the past 5 years.
4. A list of the name, address, and amount of water purchased by the largest customers. (The identity of these customers will not be revealed in the report.) Of particular interest are golf courses and other facilities that can use recycled water.

B. From water production records: The total amount of water produced and sewer flow for each month for the past 10 years.

C. 1. Maps of the major sewer and water mains.
   2. The number of miles of water mains of various sizes.

D. 1. Water and sewer rate schedules for the past 5 years.
   2. Total water and sewer revenues received for the past 5 years.

E. 1. The results of past tests for leakage.
   2. The cost of these tests.

F. 1. Description of current metering program.
   2. The current status of meter verification and inspection programs.
   3. Any data relating to the peak day water use by large water users.

G. 1. Annual water and sewer OM&R budgets for the past 10 years.
   2. Any other data which would assist in determining the relationship between water produced and operation, maintenance and repair costs.

H. 1. Capital Improvement Programs for water supply and waste water treatment for the next 50 years.
   2. Any planning documents or consulting reports prepared for projected capital improvements.
   3. Water use and sewer flow projections for the next 50 years.

I. 1. Any data relating the actual or proposed water recycling or groundwater recharge plans.
   2. Current treated effluent water quality conditions.

J. Any available data relating to the effects of water use or changes in water use in the future on other uses of water supply sources. For surface sources this may be of the nature of altered patterns of hydroelectric generation, inland navigation, recreation, water supply for other localities, etc. For groundwater sources this may be of the nature of increased pumping costs (both for the utility itself and other users), land subsidence, wildlife impacts, etc.

K. Data on any programs, plans or policies, not discussed above, which relate to water conservation or drought management.

If data will not support individual forecasts of sectoral water use, a shift-share analysis can be used. In this case, the fraction of total water use which is accounted for by each sector is forecast, with explicit attention to changes in the various fractions (changes in the structure of water use) over time. For example, residential water use may be assumed to increase gradually from 55 percent to 60 percent over time, due to changes in the pattern of development of the community. Such forecasts should be supported by analyses and projections obtained from local planning or other agencies. Justification should be presented for all forecasts of this type, even where sectoral shares are left unchanged.

(3) Estimation of Disaggregated Water Use. Nonseasonal use is taken as the rate of use by each sector during the period of the year with lowest use. This period will depend on local circumstances. A period of more than one month may be required to avoid errors associated with the billing cycle. Seasonal use is the difference between total use and nonseasonal use over the full year. These estimates are converted to estimates of the fraction of total use which is seasonal for each sector. When several years of data are available, values from high use years are often of special interest both for the effect on capital facilities and for drought contingencies.

b. Estimating the Effectiveness of Measure (R_{ijt}). The second term of the effectiveness expression, R_{ijt}, must be obtained from field studies, engineering estimates, or from published sources. The latter source should be used with caution for several reasons. First, many reported data are not measures of actual results, but *a priori* estimates of other investigators. Even where measures have been implemented and overall reductions in water use achieved, the actual effectiveness of individual measures may not have been determined. Second, effectiveness data may not be reported with respect to the affected sector of water use, but stated as a fraction of some larger aggregate. For example, the effectiveness of lawn sprinkling restrictions may be given as a fraction of overall municipal water use, rather than as a fraction of seasonal residential use. The former result is likely to be unsuitable for application to a different community, where the structure of municipal water use may be quite different. Unless actual measurements of fractional reductions in water use for the affected water use sector are available, engineering estimates, either prepared for the purpose or obtained from the literature, must be relied upon. Attention should be given to the consequences of error in these estimates, and alternate calculations employing upper and lower bounds are recommended.

c. Estimating Coverage of Measures (C_{ijt}). The fraction of use in a sector that is affected by a measure, C_{ijt}, is a combination of three factors:

(1) In some cases a measure will apply only to a portion of the water use within a user class. For example, toilet tank inserts affect water used for toilet flushing which is only a portion of residential nonseasonal use. Estimates can be obtained from published sources or engineering estimates.

(2) Partial coverage may be inherent in the measure. The measure may be voluntary or may apply to only certain areas or users. Estimates of this factor are obtained from the implementation plan.

(3) Some measures are implemented progressively over time. Examples include changes in the plumbing code which affect only new facilities, and phased leak detection programs. Estimates of this factor are also obtained from the implementation plan.

It should be noted that, for dimensional consistency, the coverage term must be expressed as a fraction of water use affected, rather than of users affected. Where users are expected to be either approximately equal in their use of water, or to be randomly distributed with respect to implementation (users covered by the measure exhibit the same frequency distribution of individual water use as those not covered), it may be sufficient to employ the fraction of users covered as an estimator for C_{ijt}.

4-9. Advantageous Effects. Water conservation measures may result in two types of advantageous effects: those which result directly from the reduction in water use, and those which result indirectly from, or are unrelated to, the reduction in water use. Identification and measurement of the first type of advantageous effect requires knowledge of the effectiveness of the water conservation measure, determined as described in Section 4-7, and information regarding the cost and characteristics of the water supply plan. The procedure for measuring this type of advantageous effect is presented in Chapter 5. The second type of advantageous effect, which does not require knowledge of the water supply plan, is described here.

Whenever water conservation measures reduce the use of hot water (low-flow shower heads, for example), energy required to heat the water is reduced in the same proportion. The foregone energy cost is an advantageous effect of water conservation, indirectly related to the reduction in water use. Other water conservation measures may produce advantageous effects which are independent of the reduction in water use. Faucet aerators may reduce splash and improve rinsing action; better lawn and garden sprinkling practices may improve the condition of certain vegetation; industrial water recycling may improve receiving water quality due to reduced effluent quantity. All these advantageous effects must be identified and measured or described.

4-10. Disadvantageous Effects. Water conservation measures may result in two types of disadvantageous effects: those which result directly from the reduction in water use, and those which result indirectly from, or are unrelated to, the reduction in water use. As in the case of advantageous effects, identification and measurement of the first type of disadvantageous effect requires knowledge of the water supply plan, and is discussed in Chapter 5. The second type of disadvantageous effects is described here under two headings: Implementation Costs and Other Disadvantageous Effects.

a. Implementation Costs. Implementation costs accompany every water conservation measure and plan, and are widespread in their effect. At one level, quantifiable and unquantifiable costs can be distinguished. Costs that are quantifiable in dollars and cents might include the responsible agency's budget for a public information campaign encouraging water conservation, or a householder's outlays for drought-resistant landscaping. Unquantifiable costs are harder to delimit and determine. They would include, for example, the opportunity costs of the responsible agency for directing management effort to one program rather than to another, or the inconvenience attributable to the procurement and installation of water-conserving devices.

Implementation costs should also be classified according to affected party. They would be divided among the public sector agencies, private sector firms and organizations, community and interest groups, and private citizens. Clearly, in calculating the costs incurred in a water conservation proposal, it will be necessary to make some judgment about the quantitative or qualitative extent of those costs that are not initially available as monetary estimates.

b. Other Disadvantageous Effects. Disadvantageous effects which are not implementation costs include such matters as lost consumer surplus associated with the use of water-conserving, but less convenient, plumbing fixtures. While many water-saving plumbing fixtures may be indistinguishable in function from their conventional counterparts, certain measures, such as flow-limiting devices on general purpose water taps, may cause some inconvenience. Where this inconvenience is expressed in the form of consumer willingness to pay more for a conventional tap, market data may be used to obtain an estimate of the willingness-to-pay lost on account of the decision to require the flow-limiting device.

Certain water conservation measures may have adverse environmental effects. Extensive restrictions on sprinkling in a humid to semi-arid climate may result in chronically brown lawns and gardens, and in some vegetation damage, with consequent loss of certain amenity values. Where such effects are anticipated, they should be documented and described.

CHAPTER 5

EVALUATION OF WATER CONSERVATION MEASURES

5-1. Overview. This chapter describes the remaining steps in the evaluation of water conservation measures, those which require knowledge of the costs and characteristics of the water supply plan. The effectiveness of each water conservation measure, determined as a part of the measure-specific analysis, is combined with cost and other information to obtain advantageous and disadvantageous effects on both the NED and the EQ objectives which result from reduced water use, as outlined in Figure 5-1. Supply costs are analyzed parametrically to obtain a separate supply cost-water use reduction relationship for each water supply plan under consideration. The estimate of measure effectiveness is then used to estimate foregone supply cost for each measure, for each water supply plan. The foregone supply costs consist of short run incremental costs, long run incremental costs, and external costs. Knowledge of the characteristics of each water supply plan also permits any effects on the EQ objective to be identified and estimated. When all advantageous and disadvantageous effects have been estimated and compared, a final list can be prepared of those water conservation measures which are technically feasible, socially acceptable and economically or environmentally feasible. These measures are used to develop alternative water conservation proposals, which comprise the appropriate water conservation elements for each water supply plan under consideration, as described in Chapter 6.

5-2. Prerequisites to Analysis. The following provides a description of those considerations common to evaluation of all water conservation measures.

a. Water Supply Operating Cost Projections. Projections of operation, maintenance, and repair (OM&R) costs must be available for all present and planned water supply activities. Typically, these projections consist of relatively simple extrapolations of current cost levels. OM&R costs should be segregated by type (labor, materials, contractual services, etc.) and purpose (water treatment, distribution system maintenance, etc.). Projected costs should include the effect of planned capital improvements. Where alternative federal plans are under consideration (NED plan, EQ plan, etc.), separate cost projections must be available for each plan. Costs of existing and locally planned facilities must also be projected.

b. Water Supply Capital Improvement Plans. Where forecast water demand cannot be met with acceptable levels of reliability by supply facilities already existing, a capital improvement plan covering the period of analysis must be available. The capital improvement plan must identify the most likely means of achieving the required supply capability, including reservoirs, source works, raw water transmission, treatment

EVALUATION OF WATER CONSERVATION MEASURES

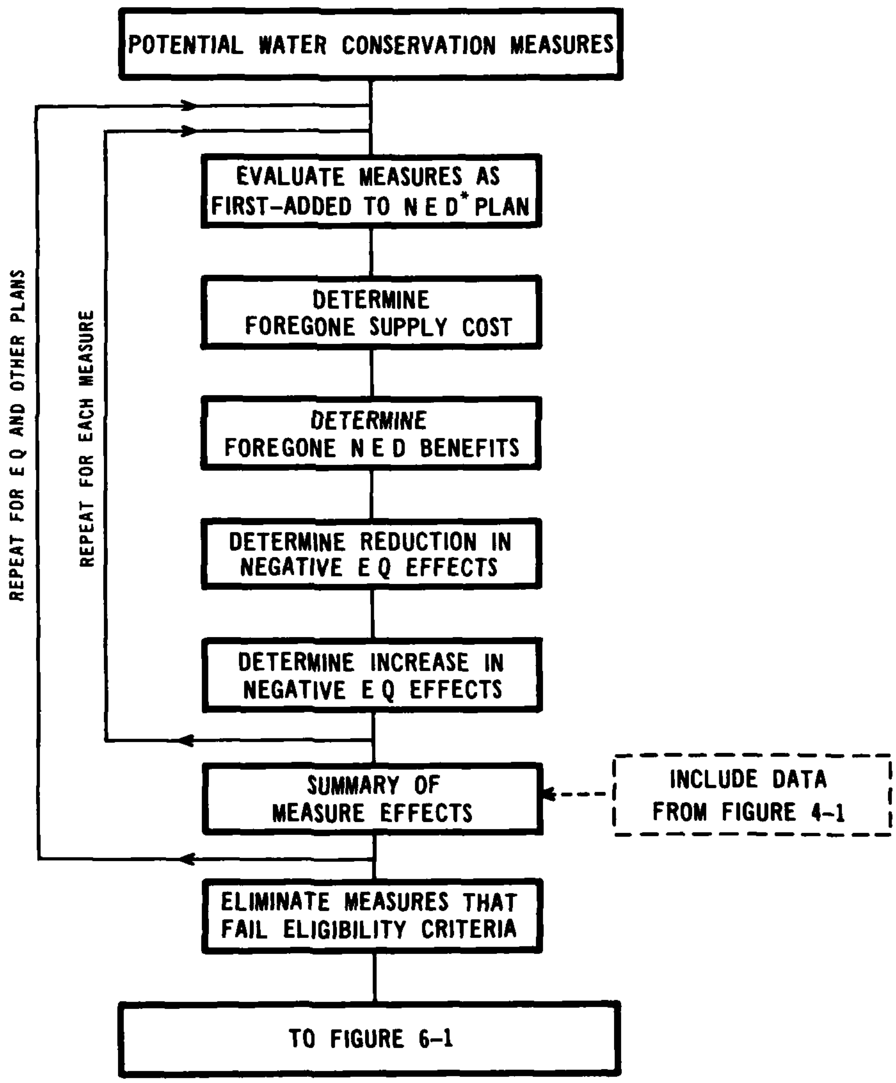


FIGURE 5-1

* N E D, E Q or Other as appropriate.

facilities, finished water storage and transmission, and any other supply facilities whose design will be substantially affected by the quantity of water used. Identification and a short description must be provided for each facility, together with its planned contribution to system capacity, its estimated cost, and the expected dates for beginning of construction and for initiation of service. Where alternative federal plans are under consideration (NED plan, EQ plan, etc.), each plan must be separately delineated, as well as any locally planned facilities required.

c. Wastewater System Operating Cost Projections. Projections of operation, maintenance, and repair costs should be available for the wastewater collection, treatment, and disposal function. These OM&R costs should also be segregated by type and function. Future values of these costs may be extrapolated from current cost levels. Only those costs which are responsive to changes in wastewater volumes (pumping costs, for example) need be specifically projected.

d. Wastewater System Capital Improvement Plans. Where capital improvements to the wastewater collection, treatment, and disposal system are planned because of anticipated increases in wastewater flow, information regarding these planned improvements must be available. Each project must be described, and its expected contribution to system hydraulic capacity indicated, along with estimated cost and expected dates of construction and of first operation.

5-3. Foregone Supply Costs.

a. Identification of Foregone Supply Costs. Water use imposes costs. These can be costs incurred in storing, treating, and distributing water to users, or in collecting, treating, and discharging the water which is used (wastewater) but not consumed. Costs can also be imposed on other users of the water resource by changes in the quantity, quality, or availability of water. Reductions in water use can decrease these costs, resulting in advantageous effects.

(1) Incremental Analysis. The cost changes of interest are normally associated with changes in water use that are small in comparison to total use. The incremental cost function represents the changes in cost with respect to (small) incremental changes in use. These cost functions are likely to be nonlinear and discontinuous if developed for large changes in water use. When a parametric approach is taken (e.g., using a fixed rate of change of annual cost per unit of sustained change in water use) care must be exercised. Using this fixed value per unit outside the range in which it was calculated can lead to serious errors. Discontinuities in the incremental cost function are likely to be found.

(2) Dimensions of Water Use. Because different types of water use affect costs in different ways it is useful to describe several dimensions of water use. Each type of cost is usually represented as a function of a single dimension of use. A specific water conservation measure may impact several types of costs by affecting several dimensions of water use. Four of the more commonly used definitions are:

(1) Maximum (peak) day use; (2) Average day use; (3) Average day sewer contribution; and (4) Average day water consumption (water not returned to the sewer). All the measures are usually expressed as million gallons per day (MGD).

(3) Application to Specific Water Conservation Measures. The normal advantageous effects estimate will be a function of incremental change in some dimension of water use. For small increments, this function may be assumed linear over the relevant range (i.e., constant benefit per MGD). The foregone costs should be expressed as annual equivalent constant dollars over the planning horizon of 50 years. These foregone costs will refer to a sustained reduction in water use. Many measures will become more effective over time so that additional advantageous effects must be estimated for reductions beginning in future years. In some cases the effect on costs will be merely displaced in time. In this case the annualized advantageous effect estimate for reductions in the current year is assumed to begin in the year the measure becomes effective. This time stream can then be converted into an annualized stream beginning in the base year. For other cases, particularly when costs are associated with lumpy capital investment, advantageous effects associated with future use reductions will be different and will have to be calculated separately for each year.

(4) Categories of Foregone Costs. Advantageous economic effects directly attributable to reductions in water use can generally be classified as one of the following types of cost reductions:

(a) Foregone Federal Plan Costs. These are changes in the future costs associated with federally planned water source, transmission, treatment, storage, and distribution facilities. Both short run and long run costs may be foregone.

(i) Short Run Incremental Costs. Short run costs are those which vary with water use while capital stock (capacity) is held constant. They include operating, maintenance, and administration costs, to the extent that they vary with water use.

(ii) Long run Incremental Costs. Long run costs are those which vary with the capacity of the water supply facilities. Reductions in water use throughout the planning period may permit certain federally planned facilities to be reduced in size, reconfigured, or postponed. The resulting change in the present value (or annualized value) of the capital costs of the federal plan is the foregone long run cost.

(b) Other Water Supply Plan Costs. In addition to the costs associated with the federal plan, future costs will be incurred to construct wastewater facilities, locally planned water facilities, and to operate and maintain existing and locally planned water and wastewater facilities. When these costs vary with water use, they are sources of advantageous effects for water conservation measures. As with federal plan costs, both short run and long run incremental costs can be identified.

(i) Short Run Incremental Costs. Short run costs are those which vary with water use while capital stock (capacity) of water and/or wastewater facilities is held constant. They include operating, maintenance, and administration costs, to the extent that they vary with water use.

(ii) Long Run Incremental Costs. Long run costs are those which vary with the capacity of water and/or wastewater facilities. Reductions in water use throughout the planning period may permit certain locally planned facilities to be reduced in size, configuration, or postponed. The resulting change in the present value (or annualized value) of the local capital improvement program is the foregone long run cost.

(c) Foregone External Opportunity Costs. These are changes in the costs borne by persons or groups other than the suppliers and users of water, which occur as a result of changes in the level of water use.

For each of these categories of costs three major steps are required: (1) identification of the costs; (2) data collection; and (3) estimation of the incremental cost functions for each of the costs within each category. These steps are discussed below for each category.

b. Short Run Incremental Supply Costs.

(1) Identification. Short run incremental supply costs include many of those expenditures which are normally categorized OM&R costs. A useful distinction can be made between those OM&R costs that are related only to the size of the capital stock (fixed short run costs) and those OM&R costs that are variable with use given a fixed capital stock (variable short run costs). Only the variable short run costs should be included when estimating short run incremental costs.

Incremental short run cost should never be less than the average variable short run cost. For an efficiently run production facility the cheapest units of output are produced first. Therefore, the average variable cost of producing all units is not greater than the variable cost of the last unit produced (which is the incremental short run cost). Short run incremental costs are represented by the slope of the function that relates total OM&R costs to total output.

From the above discussion it should be clear that short run incremental costs (dollars per unit) can vary with changes in use. As total output approaches capacity incremental costs rise rapidly. Additions to capacity will. therefore, affect the value of incremental costs.

Short run incremental costs can also include items that are not included in the OM&R expenditures. This can result because certain resources used by the utility(s) may be obtained from other city agencies at no charge. Utilities can also impose costs upon themselves which are not segregated in expenditure data. This is particularly true for ground water pumping where each unit pumped can increase the cost of other units pumped.

(2) Data Collection. Data items A.2, B., and G., shown in Table 4-1., are used in estimating the short run incremental cost function. Projected short run costs for the federal plan are obtained from documentation of the water supply plan. Interviews with water utility personnel can also be helpful. Some utilities use their treatment plants or wells in the order of least cost first, thus the variable costs associated with the higher cost plants or wells are the incremental costs. This must usually be discovered through interviews with utility personnel.

(3) Estimation. Before the cost functions can be estimated several operations should be performed on the OM&R budgets. Only actual expenditures, rather than appropriations, should be used. All obvious fixed (with respect to water use) costs (administration, billing, water quality monitoring, etc.) should be removed. If major discontinuities separate older from newer data the older data should be discarded.

Average variable (or potentially variable) cost values can be useful in setting bounds on incremental cost values. Further refinement can sometimes be achieved through the use of regression of short run costs on water use or sewer flow. A very limited number of other variables (e.g., number of connections) should be included if thought (a priori) to significantly influence water use. Repeated attempts to fit variables or functional forms should be avoided as this can seriously bias regression statistics.

c. Long Run Incremental Supply Costs.

(1) Identification. Long run incremental supply costs represent the advantageous effects associated with use reductions which allow water and sewer utilities to delay or reduce in size future capital expenitures without reducing the quality of service. Identification of these costs requires knowledge of the capacity expansions included in the federal plan, already locally planned, and likely to be locally planned as well as of the parameter(s) of water use which determines the time of construction of each facility. Among the parameters of use that determine the timing of capital facilities are average day use, maximum day use, and average day sewer contributions.

(2) Data Collection. For facilities not included in the federal plan, data items in H. of Table 4-1 are used in estimating long run incremental supply cost functions. Of these the most valuable are the

planning and consulting reports. These very often contain descriptions how the timing and sizing determinations are made. Supplemental interviews with employees of the utility and their consultants are often necessary.

(3) Estimation. The procedure for estimating long run incremental cost functions involves estimating the present value of changes in the capital improvement program that are likely to result from a sustained change in water use. These changes, estimated separately for federally planned and nonfederally planned facilities, can then be annualized to provide annual cost savings that can be compared to annual water use reduction. These functions are likely to be nonlinear and discontinuous if taken over large changes in water use. The foregone cost per unit of water saved can also vary with the time the water savings are initiated. Once a large capital facility is completed changes in water use cannot affect its costs. Delaying a capital facility can save not only capital costs, it can save the fixed portion of the OM&R costs that are related to the size of the capital stock during the time of delay. All capital and OM&R cost savings must be annualized over the period of analysis.

One of the most important aspects of estimating these cost savings is the determination of the parameter of water use that is used in timing and sizing capital facilities. In many cases the following parameters are used for sizing each of the types of facilities listed below:

(a) Maximum day use (including losses) for water treatment, finished water storage, and transmission facilities.

(b) Average day water use for large raw water storage facilities.

(c) Average day sewer contribution for wastewater treatment and transmission facilities (often infiltration and inflow is added). Some elements of wastewater treatment are related to total loadings of biochemical oxygen demand or solids and will not be affected by changes in water use. The timing of some investments may be primarily determined by the desire to upgrade effluent quality. Total use may only affect the size of these capital investments, not their timing.

In some cases it will be unclear whether a small incremental use reduction will be considered in the planning process. Of course, if it is not the investment program will be unaffected. Advantageous effects will still be present in the form of increased quality of service (system reliability, effluent quality, etc.). For an efficiently operated utility, capital improvements will be made up to the point where the incremental benefit of the last improvement in terms of quality of service is equal to the incremental cost.

Therefore, for changes in use that are small relative to total use the potential (but possibly unrealized) cost saving can provide a good approximation of the benefits of the improved quality. The fact that the utility will choose to take the benefits in the form of increased quality rather than reduced costs indicates that the advantageous effects of improved quality are worth at least as much as the cost of saving.

In determining the extent of the size reduction, or delay in construction, of a capital facility which is to be identified as an advantageous effect of conservation, attention must be given to the implied design practice of the utility. Where facilities are designed to be adequate for a specified design drought, more severe droughts can be accommodated by emergency water use reduction measures. The implementation of water conservation may reduce the future effectiveness of such emergency measures, requiring a larger margin of safety between supply and expected demand, if system reliability is to be unaffected. Long run incremental cost functions should incorporate these considerations, where necessary.

Many times capital improvement programs are not available or are only available for the next several years. In these cases judgment must be exercised as to a reasonably likely capital improvements program based on the characteristics of the federal plan and the current practices of the utility.

d. Foregone External Opportunity Costs.

(1) Identification. These costs include all costs not mentioned above. Identification of external opportunity costs requires the identification of the other users of the resource. These will generally fall into one of four categories:

(a) Changes in inland waterway navigation patterns or in the operating or capacity costs associated with maintaining sufficient depth in waterway channels.

(b) Changes in the value or amounts of recreational services, often measured as changes in the number or value of user days. Changes in the market value of recreational properties are also a potential means of measuring a portion of these benefits.

(c) Changes in quantity, quality or availability of water supplies to other municipalities, industries or agriculture. In areas where water is almost completely appropriated, such as the Southwest, these may be equivalent to the net value of the water in its most likely use.

(d) Changes in the value or amount of hydroelectric energy. Both upstream and downstream facilities can be affected when release rules are altered to make water available to the utility at the desired times.

(2) Data Collection. Data item J. of Table 4-1 will provide information on potential users of the water resource that may be impacted by changes in water use. Interviews with the person or group affected will be necessary to determine the nature of their water uses and the likely effects of changes in water use by the utility.

(3) Estimation. The proper framework for estimating foregone external opportunity costs is to determine how much would have to be collected from another use to leave that person or group just as well off after the decrease in use. It is of no consequence to this analysis whether such transfers actually take place. In all cases the effects which are judged most likely to actually occur are the effects which should be evaluated and estimated.

e. Measurement of Foregone Supply Costs. The effectiveness of each conservation measure, determined as described in section 4-7, is combined with the supply cost-water use reduction relationships (obtained as described in paragraphs 5-3.b, 5-3.c, and 5-3.d) corresponding to one alternative water supply plan (such as the NED plan). The result is a measurement of the advantageous economic effects attributable to the reduction in water use, given implementation of that plan. This process is repeated for each alternative federal plan under consideration, giving an estimate for each.

Effectiveness is multi-dimensional: it may be reflected in changes in average day water use, maximum day water use, and/or average day sewer contribution. Each dimension of effectiveness may affect short run incremental costs, long run incremental costs, or external opportunity costs. Calculations must be performed for each combination of type of effectiveness and type of cost effected. Each calculation provides an estimate of incremental cost foregone, expressed as an annualized cost. The estimates must be summed to yield the annual advantageous effect attributable to the water conservation measure.

Since both effectiveness and annualized costs vary from year to year, the level of annual advantageous effects will, in general, vary as well. They will be zero prior to implementation of the conservation measure and equal to foregone supply cost thereafter. This nonuniform stream of annual effects must be discounted to present value at the base year, then annualized again to provide a uniform annual advantageous effect measurement for each water conservation measure.

5-4. Foregone NED Benefits. Where the water supply plan is a part of a multi-purpose federal plan, alterations in the scale, configuration, or timing of the water supply portion may reduce net benefits obtained from other purposes. This reflects the joint product nature of certain of the project outputs, such as water supply and recreation. Reductions in the size of the reservoir, for example, may reduce its attractiveness and capacity as a recreational site. The resulting reduction in future utilization of the site reduces both NED benefits (lost user-days) and NED costs (less operating and maintenance expense). In an optimally designed project, the lost NED benefits will exceed the lost NED costs, giving a net loss of NED benefits. Similar relationships may exist for water supply and hydropower, and, in some cases, water supply and flood control. In every case, lost NED benefits attributable to water conservation must be identified and measured, and recorded as a disadvantageous effect of the water conservation measure under question.

5-5. Reduced Negative EQ Effects. Reductions in water use or in water losses may alter the (generally negative) effect of the federal project and existing or planned local facilities on the EQ objective. Water conservation may have an advantageous EQ effect (by reducing the negative EQ effects of water supply facilities) or a disadvantageous EQ effect (by increasing negative EQ effects).

Advantageous effects arise under two general types of circumstances:

(1) Less intensive use of existing supply facilities results in increased streamflows during low-flow periods, in reduced risk of subsidence due to groundwater overdraft, in reduced drawdown of existing reservoirs, etc.

(2) Lower water use permits planned water supply facilities to be postponed, scaled down, or avoided altogether, thus postponing, reducing, or avoiding the associated negative environmental effects.

Where such effects can be identified, they should be described and quantified, where possible, for the water use reduction associated with each water conservation measure under consideration for each alternative federal plan.

5-6. Increased Negative EQ Effects. Circumstances may arise where reductions in water use increase the negative environmental impact of the combined federal project and existing or locally planned facilities. For example, a less environmentally damaging federal project may be planned to completely replace existing facilities which are associated with significant negative environmental effects. If the effect of water conservation is to postpone the construction of the federal project, the consequence could be increased negative EQ effects over the planning period. In every such case, the effects should be identified, described, and quantified, where possible, for the water use reduction associated with each conservation measure under consideration, for each alternative federal plan.

5-7. Measure Evaluation. Individual water conservation measures are analyzed for advantageous and disadvantageous effects, first on a measure-specific basis (Chapter 4), then for the additional effects that are directly associated with reductions in water use (Chapter 5). Since these last effects are determined by the characteristics of the planned water supply facilities, where alternative federal plans exist, alternative determinations of advantageous and disadvantageous effects must be made. Following these determinations, all effects should be summarized, and measures which fail to meet eligibility criteria are eliminated.

a. Summary of Advantageous and Disadvantageous Effects. Table 5-1 presents an outline which can be used to summarize advantageous and disadvantageous effects for each water conservation measure. Where alternative federal plans are under consideration, alternative measures of advantageous effects A.1.c.i, A.1.c.ii, A.1.c.iii., A.1.c.iv, A.1.c.v., B.1.b.i., and B.1.b.ii. will generally be required, one for each alternative plan. Similarly, alternative measures of disadvantageous effects A.2.c., B.2.b.i., and B.2.b.ii. will also be required.

b. Eligibility Criteria. Water conservation measures which are to be considered for inclusion in a water conservation proposal must pass several tests. They must be applicable (Section 4-3), technically feasible (Section 4-4), and socially acceptable (Section 4-5). Where measures are judged potentially technically feasible, or potentially socially acceptable, they should be included in the analysis on the understanding that implementation is contingent upon the satisfaction of specific conditions. The final criteria for eligibility are:

(1) The combined advantageous NED effects must outweigh the combined disadvantageous NED effects; and/or

(2) The combined advantageous EQ effects must outweigh the combined disadvantageous EQ effects.

Measures which meet these conditions can be assumed to have also met the Principles and Standards tests of acceptability, effectiveness, efficiency, and completeness, and can be considered for integration into the federal plan, as described in Chapter 6.

TABLE 5-1

SUMMARY OF ADVANTAGEOUS AND DISADVANTAGEOUS EFFECTS OF WATER CONSERVATION MEASURES

A. NED Effects

1. Advantages

a. Unrelated to reduction in water use (Section 4-9)
b. Indirectly related to reduction in water use (Section 4-9)
c. Foregone supply cost

i. short run incremental costs for federal plan (Section 5-3.b.)
ii. long run incremental costs for federal plan (Section 5-3.c.)
iii. short run incremental costs for non-federal facilities (Section 5-3.b.)
iv. long run incremental costs for non-federal facilities (Section 5-3.c.)
v. foregone external opportunity costs (Section 5-3.d.)

2. Disadvantages

a. Implementation costs (Section 4-10.a.)
b. Other disadvantageous effects unrelated to, or indirectly related to reductions in water use (Section 4-10.b.)
c. Foregone NED benefits (Section 5-4)

B. EQ Effects

1. Advantages

a. Advantageous effects unrelated to, or indirectly related to reductions in water use (Section 4-9)
b. Reductions in negative EQ effects of water supply facilities

i. associated with federally planned facilities (Section 5-5)
ii. associated with non-federally planned facilities (Section 5-5)

2. Disadvantages

a. Disadvantageous effects unrelated to, or indirectly related to reductions in water use (Section 4-10)
b. Increases in negative EQ effects of water supply facilities

i. associated with federally planned facilities (Section 5-6)
ii. associated wi h non-federally planned facilities (Section 5-(

CHAPTER 6

INTEGRATION OF WATER CONSERVATION INTO WATER SUPPLY PLANS

6-1. Overview. Evaluation of water conservation measures, described in Chapter 5, results in a list of eligible measures, with all advantageous and disadvantageous effects identified and measured or described for each measure. Where alternative federal water supply plans are under consideration, certain of the advantageous and disadvantageous effects must be estimated separately for each federal plan. In order to integrate water conservation measures into the federal plans, individual measures must be combined to form water conservation proposals; the proposals become the water conservation elements of the federal plans. Alternative federal plans may attempt to maximize contributions to the NED objective, to the EQ objective, or to realize selected tradeoffs between the objectives (other plans). Similarly, water conservation proposals can be developed so as to enhance desired features of the final water supply/conservation plan. The following sections describe the development of water conservation proposals suitable for integration into the various alternative federal water supply plans, illustrated by Figure 6-1.

6-2. Proposal Development Principles.

a. Eligible Water Conservation Measures. The water conservation measure to be considered in the development of water conservation proposals are those found eligible according to the criteria given in Section 5-7.b.

b. Merit Order. Because of the possibility of interactions among individual water conservation measures, it is helpful to introduce individual measures into each alternative water conservation proposal in merit order -- the "best" measure is included first, followed by the next "best," etc. The definition of "merit" depends upon the objective of the water conservation proposal -- a proposal intended to maximize contributions to the NED objective implies a different notion of merit than does a proposal directed to the EQ objective, for example.

(1) NED Objective. For purposes of developing the water conservation proposal which makes the maximum net contribution to the NED objective, water conservation measures are arranged in order of decreasing net NED advantage. The net NED advantage is defined as the sum of all advantageous NED effects less the sum of all disadvantageous NED effects.

(2) EQ Objective. For purposes of developing the water conservation proposal which makes a maximum contribution to the EQ objective, water conservation measures are arranged in order of decreasing net EQ advantage. The net EQ advantage is defined as the sum of all advantageous EQ effects, less the sum of all disadvantageous EQ effects. Where environmental effects are diverse, considerable

INTEGRATION OF WATER CONSERVATION INTO WATER SUPPLY PLANS

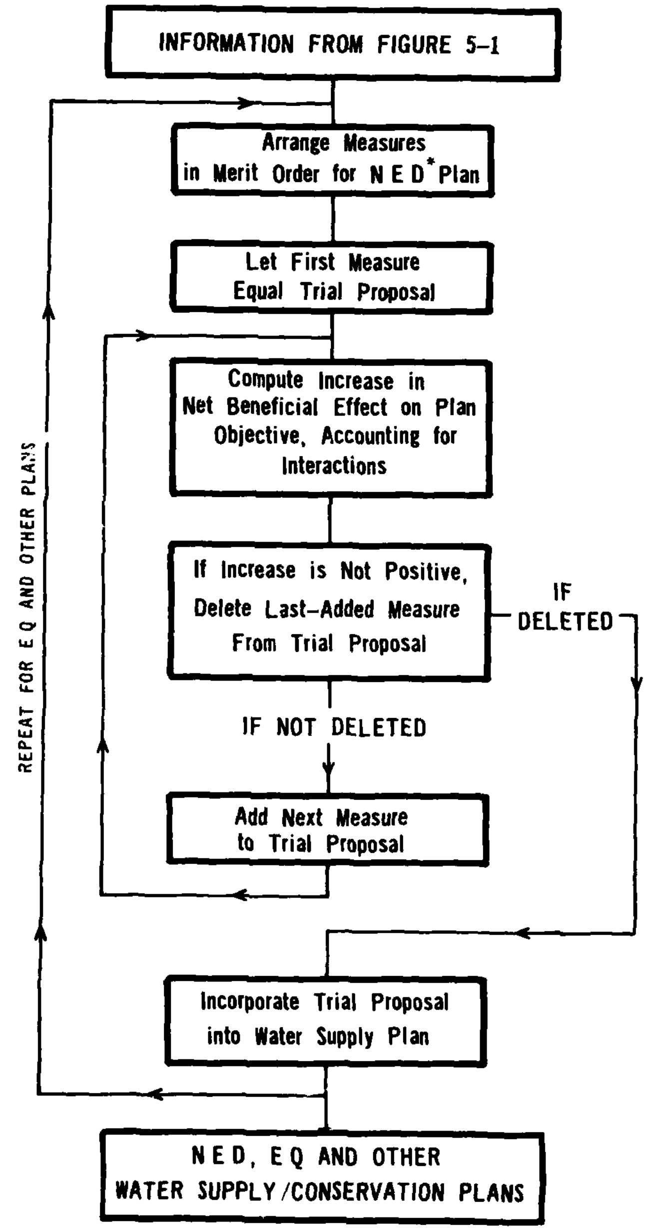


FIGURE 6-1

* N E D, E Q or Other as appropriate.

judgment may be required to achieve this ranking. If two or more measures are found whose net EQ advantage is indistinguishable, they should be listed in order of decreasing NED advantage.

(3) Other Plans. Other plans may be proposed which effect significant tradeoffs between the NED and the EQ objectives. Such plans are judged according to a selected combination of the two objectives. Water conservation measures are arranged in decreasing order of their individual contributions to the same combination of objectives.

c. Interactions. Water conservation measures can be expected to exhibit interactions with respect to both effectiveness and implementation costs. In some cases, interactions may also appear for other advantageous and disadvantageous effects, including environmental effects. Interactions with respect to effectiveness appear when two different conservation measures impact the same water use or water use behavior. For example, restrictions on lawn irrigation reduce the amount of water use for this purpose, but changes in the summer price of water also affect the same water use. The effectiveness of both measures, implemented together, would be strictly less than the sum of the effectiveness of the two measures implemented individually. In fact, whenever metering and pricing measures are implemented in conjunction with other water conservation measures, interactions can be expected.

Interactions with respect to implementation costs appear when two measures share common implementation characteristics. Typically, the implementation of two measures at the same time results in costs borne by the water utility and/or public agencies which are less than the sum of costs of implementing the measures individually. In most cases, joint implementation can be expected to reduce aggregate implementation costs. This interaction is most striking in the case of educational efforts.

d. Net Beneficial Effects. As individual water conservation measures are added to trial water conservation proposals, the net beneficial effect of adding the additional measure must be determined. In every case the net beneficial effect is defined with respect to the plan objective -- in the case of the NED plan it is the net beneficial NED effect, in the case of the EQ plan it is the net beneficial EQ effect, etc. It is found by determining the excess of all advantageous effects on the plan objective over all disadvantageous effects on the plan objective before adding the additional measure, then determining the same excess after adding the additional measure, and finally noting whether the second amount is greater (increase in net beneficial effect) or less (decrease in net beneficial effect) than the first.

6-3. Development of Alternative Conservation Proposals.

a. NED Objective. The proposal which makes the maximum net contribution to the NED objective is developed from the list of eligible water conservation measures, arranged in suitable NED merit order and evaluated on the basis of the NED water supply plan (Section 6-2.b.(1)). Proposal development begins by choosing the first listed measure. The second measure is then added to the first. Tentatively, the advantageous effects of the second measure are added to those of the first, and the disadvantageous effects are added. Interactions between the two plans are investigated, and the summed effects adjusted where necessary. For example, if the two measures interact with respect to effectiveness, such that their combined effectiveness is less than the sum of their effectiveness, advantageous NED effects must be adjusted downwards.

If the water conservation proposal now formed (two measures) exhibits a net contribution to the NED objective (net beneficial effect) which is larger than that recorded for the immediately preceding plan (one measure), the second measure is retained and the development proceeds. If the proposal development proceeds, additional measures are tentatively added in the same way, effects are summed, interactions are investigated, summed effects are adjusted where necessary, and the net beneficial effect is tested. Development stops when the next measure in the merit order list fails to contribute to the net NED effect: when the contribution to the NED objective is maximized. The measures then included comprise the water conservation element of the NED water supply/conservation plan.

b. EQ Objective. The proposal which makes the maximum contribution to the EQ objective is developed from the list of eligible water conservation measures, arranged in suitable EQ merit order and evaluated on the basis of the EQ water supply plan (Section 6-2.b.(2)). The second measure is then added to the first. Tentatively, the advantageous effects of the second measure are added to those of the first, and the disadvantageous effects are added. Interactions between the two measures are investigated, and the summed effects adjusted where necessary.

If the water conservation proposal now formed (two measures) exhibits net beneficial effects on the EQ objective which are judged to be not less than those observed before the first measure was added, the second measure is retained and the development proceeds. If not, the second measure is removed and the development stops. If proposal development proceeds, additional measures are tentatively added in the same way, effects are summed, interactions are investigated, summed effects are adjusted where necessary, and the results are tested. Development stops when the next measure in the merit ordered list reduces the cumulative net beneficial effect on EQ. The resulting conservation proposal comprises the water conservation element of the EQ water supply/conservation plan.

c. Other Plans. Other plans reflect trade-offs between the planning objectives (NED and EQ), or between one of the planning objectives and other considerations.

Conservation measures can be merit-ordered and the conservation proposal developed in a manner analogous to that described above for the basic plans. Effects of individual measures are estimated on the basis of the other water supply plan. The merit order should reflect the objectives of the other plan. For example, if a compromise between NED and EQ objectives is sought, measures with net beneficial effects on both objectives would be listed first, followed by those considered less desirable in view of both objectives, etc. The proposal formulation then proceeds until the mix of NED and EQ desired in the plan cannot be enhanced by adding other measures.

d. Treatment of Potentially Feasible or Potentially Acceptable Measures. As noted in section 6-2.a., some eligible water conservation measures may not be feasible or acceptable under existing physical or social conditions. These measures are categorized as "potentially feasible" or "potentially acceptable", and the conditions under which they would become feasible in the future are specified. Initially, such measures are included in the list of eligible measures, and in the development of water conservation proposals, as described in sections 6-3.a. through 6-3.d. Whenever one of the final water supply/conservation plans includes potentially feasible or potentially acceptable measures, however, a second plan will be developed on the same criteria, except that potentially feasible and potentially acceptable measures will be excluded from the list of eligible measures. Both plans will be presented for comparison, so that the consequences of not implementing the potentially feasible or potentially acceptable measures can be contrasted to the difficulty of removing impediments.

6-4. Supply Reliability Considerations. As indicated in paragraphs 2-3 and 5-3.c.(3), the advantages of water conservation result largely from possible reductions in supply capability, when system reliability is held constant. If the overall reliability of the supply system is altered by the implementation of water conservation practices, additional disadvantageous or advantageous effects are created. The need to identify and measure these additional effects can be avoided by holding system reliability constant throughout the analysis. Following development of alternative water conservation proposals, this assumption should be tested by determining the performance of each alternative supply plan, with and without the water conservation element, for the last year in the planning period assuming design drought conditions. Supply plans with water conservation will differ from those without this element in having down-sized or delayed construction schedules, as well as lower levels of water use. Where water deficits appear for the design drought conditions, emergency water use reduction measures (not already incorporated in the water conservation proposals) are required. The extent and severity of measures required for supply plans which incorporate conservation should not exceed those for the corresponding supply plans without conservation.

6-5. <u>Documentation of Water Supply/Conservation Plans</u>. The procedures described in the previous sections will result in one or more water conservation proposals which can be integrated with water supply plans to form water supply/conservation plans. Wherever proposals include potentially feasible or potentially acceptable measures, alternative plans will be developed which exclude these measures. The documentation of each water supply/conservation plan must include:

(1) The full list of applicable water conservation measures considered, showing which measures were excluded as not technically feasible, which were excluded as not socially acceptable, which were excluded as not eligible by reason of negative impacts on the NED and EQ objectives, and which were excluded in the process of plan formulation.

(2) A list of water conservation measures considered not applicable because they are already implemented, or definite commitments have been made to implement them within the planning area.

(3) A list of each water conservation measure included in the proposal, with a full description for each measure, indication of the agency or other entity responsible for its implementation, and a summary of the implementation plan including estimated coverage and duration.

(4) Aggregate implementation cost for the water conservation proposal, expressed as annualized cost; implementation cost for the proposal identified by responsible party (utility, residential water users, etc.).

(5) Aggregate effectiveness for the water conservation proposal, shown separately with respect to average day water use, maximum day water use, and average day sewer contribution; shown for selected times throughout the planning period.

(6) A description of the federal water supply plan, without water conservation, including a summary of beneficial and adverse effects as required by the Principles and Standards.

(7) A description of the federal water supply/conservation plan, incorporating the water conservation proposal, including a summary of beneficial and adverse effects as required by the Principles and Standards.

(8) A summary of the performance of the water supply plan (without conservation) and the water supply/conservation plan for the last year of the planning period under design drought conditions. Data provided shall include projected supply capability, projected water use (including maximum day use), and the nature and assumed effectiveness of emergency water use reductions measures required, if any.

APPENDIX A

THE MEASUREMENT OF SOCIAL ACCEPTABILITY

APPENDIX A: The Measurement of Social Acceptability

A particular water conservation measure may be technically possible, effective, and economically efficient, and yet when proposed, be rejected. In an effort to understand why, an investigator might discover that the measure had been perceived by the public or by the city council or other community powers as violating the rights of private property, or as unfairly placing the heaviest economic burden on those least able to pay, or as interfering with the prerogatives of local government, etc., etc. In realistically assessing the chances a given measure of conservation has of being implemented, it is but a short distance from the familiar concepts and methods of technical and economic considerations to the alien territories of values, beliefs, attitudes and feelings -- of what may be termed "social ideologies."

But it is clear that if a measure is to be implemented, it must not only be objectively acceptable, that is, technically and economically possible, it must also be subjectively acceptable, that is, <u>it must be seen as congruent with the social ideologies or value systems of those who hold the power of decision</u>. That is the definition of social acceptability.

Determining the social acceptability of conservation measures, then, requires the measurement of social <u>ideologies</u>. These are admittedly elusive -- resistant to definition and to measurement; one must settle for something less than perfect clarity or precision. Fortunately, the refinements of measurement necessary for adequate technical and economic analyses are not needed for the assessment of social acceptability. It is not necessary to know the height of a mountain in inches in order to determine whether one should climb or go around it -- a general estimate will suffice. Similarly, social ideologies loom large, they can be readily identified; it is not necessary to measure them exactly in order to determine whether they will increase or decrease the acceptability of a given conservation measure. But it <u>is</u> necessary to pay particular attention to them, to marshal resources of time and funding and know-how so that the general shape of a community's values, as they bear upon water conservation, can be outlined.

Social ideologies, those constellations of values, attitudes, beliefs and feelings that characterize particular groups and communities, have long been the subject of the social sciences; it is they who provide the methodological approaches -- the interview and the survey -- for their delineation. But two crucial decisions must be made before an interview or a survey can be implemented. First, <u>who</u> is to be interviewed or surveyed. That is, who are the individuals or groups that directly or indirectly hold the power of decision regarding water conservation. Second, <u>what are the issues</u> the discussion of which promise most understanding of the values of the community most relevant to conservation. The answers to both questions are, of course, matters of judgment; it is important that such judgments be informed.

1. Initial Identification of Advisors. It is with its own staff that each Corps office should begin; their own work has sensitized them both to what issues figure importantly in their community as well as to who are the representatives, formal or informal, of the various interest groups marshalled on the various "sides" of those issues. This information is obtained from past experience of the Corps staff and the current, on-going public involvement program.

Of course, to a considerable extent, the nature of American society will determine what many of these community issues and community powers will be. Business and industry, labor, government, and electorate (and groupings within it such as by income or by home ownership) -- these are "standard" interest groups and easily identifiable. But there will be other interests that are site specific, for example, particular racial or language groups, farmers, or conservation organizations. And in either case, the representatives of such interests will vary by site. Thus, in one community, it may be the Chamber of Commerce that is the locus of financial power, in another, it may be a homebuilders association; in one city, the Sierra Club may constitute a major power for conservation while in another, the values of conservation may be aligned with a political party. Further, the general environmental issues which unite or divide such interests will vary by site. In one city it may be the question of whether to build a throughway, in others the live issues may be the effects of increases in real estate taxes, the location of low income housing, or the promotion of urban growth.

Corps personnel will be able to identify, at least on a general level, many such community issues and forces. But most importantly, they will know who will know them; that is, who it is that knows the community well, who it is that can act as community advisors. Selecting such advisors is the first step in conducting a social acceptability study.

2. Identification of Environmental and Social Issues, Influential Individuals and Organizations. The second step is to draw from the community advisors what they know and to organize it. Interviews with such advisors can be quite informal, the questions should be broad and open-ended -- the goal is always to identify the various powers in the community and the issues which unite or separate them.

The quickness of the yield of such a process is remarkable: within a dozen or so interviews with the most varied of advisors, patterns and themes begin to appear. The same problems and concerns are identified again and again -- "There's going to be a hell of a fight between the city and the suburbs over the location of the dam," or "Business has put the city on notice, they'll move to the suburbs if taxes are increased." And the same persons are named: a university professor, the head of an engineering firm, and a member of the Sierra Club will individually insist that "If you want to talk to someone who controls growth in this town, you've got to get to John Doe, the president of the Real Estate Association."

The data from this initial inquiry almost literally organize themselves. Two lists emerge -- one made up of those general environmental issues (fused with political, economic and social issues) that most concern the community, and another naming those organizations and individuals who most influence those issues.

3. Sample Selection and Instrument Design. The next step in the study of social acceptability can then proceed. The list of influential persons constitutes one sample of the study, a sample of "community powers." The second sample is always drawn from the ultimate community power -- the general public. And the list of issues constitutes the "topics for discussion," the content of the discussion with both samples whether done directly in the face-to-face interview as with the influentials, or indirectly, by way of a mail survey of the public.

There are several central tasks that define this stage:

(1) From the list of possible candidates identified by the advisors, a specific sample of people who are influential in the community to be interviewed is selected. Care must be taken that "all sides" are represented.

(2) A guide which will direct the interview is constructed. Essentially, the guide is a series of questions that evokes responses to a selection of those important general community issues identified by the advisors, and to those specific water conservation measures the Corps wishes to explore. The questions have two goals: first, to evoke discussions that will indirectly illuminate those fundamental values and beliefs of the community that constitute the context of ideology within which specific conservation measures are evaluated as they are held by the interest group the individual represents; and secondarily, to determine interest group attitudes toward specific conservation measures.

What should be the size of a public sample, and how does one ensure its representativeness. More practically, how does one go about getting specific names and addresses. There is no law that determines proper sample size; rather, it is a matter of judgment and a matter of how many dimensions one wants to use in the analysis. Thus, if one is interested not only in how the public, in general, evaluates a given conservation measure, but also how persons of different educational levels and different races and different sexes might differ in those evaluations, then the sample must be sufficiently large to accommodate those divisions of the data. Full treatment of such questions requires professional expertise in sampling procedures. But rigorously correct sampling is not a necessity -- a modest sample randomly drawn from a phone book will be adequate to the modest goal of the questionnaire -- estimating public response to possible ways of conserving water.

A survey mail questionnaire for the general public is designed. The purpose of the questionnaire is more limited: its goal is restricted to measurement of public response to specific conservation measures. The question of determining core values as they exist in the general public is generally one of interpretation, that is, of examining their assessment of given conservation measures in the light of information learned from the interviews.

Although easy to specify the tasks of this stage of a study on social acceptability -- the selection of sample and the design of instruments -- they are not so straightforwardly accomplished. The general question of how much Corps personnel can do themselves versus the extent to which research specialists are needed will be discussed later. Certainly, however, it is possible to provide some general guidelines for instrument construction and use.

For the Interview Guide. 1) The Interview Guide should cover two areas. First, there should be questions directed at an examination of a number of specific conservation measures. It is suggested that the list of measures to be reviewed include one from each classification category (Table 3-1). Other measures, of special interest to a particular Corps office, can then be added.

2) Second, there should be questions that explore those issues which the advisors have identified as areas of community concern. It should be kept in mind that while the purpose of the first line of questioning is to discover how and why specific conservation measures are evaluated as they are, and the purpose of the second line of questioning is to identify basic values, that frequently the two areas will overlap. Thus, for example, in his discussion of pricing as a conservation measure, a respondent may touch upon a number of ideological issues -- the proper role of government, the desirability or undesirability of urban growth, the problem of welfare, etc. And vice versa, in his discussion of any one of such issues, the respondent may focus on pricing as a good or bad method of encouraging conservation.

3) It is essential that the questions asked in the interview be perceived as appropriate. That is, it is the Corps that is either itself conducting the study or having it done; and the overall subject of the interview is water conservation. The questions then, must be seen as reasonably coming from that source, and as reasonably related to that subject. Thus, for example, community advisors may have identified racial tension as an issue with possible implications for particular conservation measures, say, pricing policies. But interview respondents would most probably perceive a direct question concerning racial antagonism as irrelevant both to the Corps and to the subject of water conservation. Thus, rather than a question such as: What do you think about race relations in this community?, the subject should be approached by an indirect question, such as: Do you think that increasing block rates might be perceived by the community as having a different impact on blacks and whites? That question would be seen

as "proper," because it fits the respondent's definition of the Corps and its work. Although the initial response to such a question might indeed be limited to the subject of pricing, skillful probes could easily lead to an expanded discussion of the broader underlying issue.

4) The opening question in any given area should be general and open-ended. The guide should give "room" to the respondent -- it must be remembered that one is interested in determining general values and attitudes, that is, ideologies that function as principles and are thus applicable to the full range of conservation measures. For example, a question directed specifically at the respondent's assessment of possible conflict between city and state jurisdictions regarding the location of a renovated wastewater facility may indeed give you that information, but only that information. Whereas a more general question which evoked discussion of the issue of conflicing jurisdictions would have revealed the respondent (and the group he represented) to be extremely protective of local government authority in general, and to see any actions by higher levels of government -- county, state, or federal (including, perhaps, Corps activities), to be unwarranted and unwanted incursions into local autonomy. Or, on the other hand, such a general question might have revealed an opposite stance, one which expressed a receptance to, even an appeal for, the entrance of county, state or federal authorities into local affairs. Indeed, there might be an expression of despair over the efficacy of local government.

In both cases one has learned something more valuable than either respondent's position on the jurisdictional conflict regarding the location of the treatment facility; one can also predict their stance on jurisdictional matters <u>in general</u>, including those relevant to possible future conservation measures.

5) Follow-up questions (probes) should pursue both objectives of the interview. As already stated, the interview's primary goal is to identify general social ideologies; its secondary purpose is to elicit specific responses to specific conservation measures. Too often, follow-up questions satisfy this latter aim only because they tend to focus on progressively narrower issues. For example, in discussing as a possible conservation measure the imposition of a tax on swimming pools, a respondent may have condemned such a proposal as a discriminatory tax on the rich. He might have argued that, in effect, it would constitute a differential increase in the price of water, and that "The price of a gallon of water should be the same no matter who's paying for it."

Rather than only probing such a response for further details, questions should be directed at exploring the particular definitions of equality and justice that underlie it. Thus, the interviewer might comment that such a proposal was presumably based on the same logic as the progressive income tax, or put another way, on the "ability to pay," and what were the respondent's ideas in general on that principle? Although seemingly removed from the subject of water conservation, the discussion of such a question would be far more illuminating of the respondent's over-all ideological stance, and thus, in the end, be of greater relevance to an understanding of his assessment of various conservation measures, many of which touch upon the conflict between the two conceptions of fairness -- equality and equity -- that run through American society.

6) The above example illustrates another important point -- the scope of the interview questions. The question might be raised: If our interest is in identifying basic social ideologies, why not immediately ask the respondent for his ideas on equality and equity. For two reasons: the first has already been discussed -- out of the context which evoked it, the questions would appear as inappropriate to the Corps' business. Second, although interested in basic social ideologies, the scope of that interest must be limited. No such study could either hope or wish to delineate the entire American conscience; rather, the goal is to understand those aspects of ideology, those values and attitudes that are most relevant to water conservation issues. In determining which values meet that criterion, one follows the lead of the respondents. Thus, the interviewer raised the issue of fairness defined as equality and fairness defined as equity because it was implicit in the respondent's more particular remarks on the swimming pool tax.

For the Questionnaire. In contrast to interviews with community influentials, any method, mail questionnaire or other, which attempts to gather data from a relatively large sample of the general public should consider first, that generally, the public will be less knowledgeable concerning community issues in general and conservation issues in particular. And second, generally, the public will be less interested in or concerned about such issues (unless, of course, they have become causes célèbres). Then, too, methods that are sufficiently efficient to gather data from large numbers cannot be as personally persuasive as individual letters and phone calls inviting cooperation.

As a result then, of less knowledge, less commitment, and less social encouragement to participate, the public cannot be expected to devote either as much time or as much energy to the study as the interview sample. The conclusion is that any method used to gather data from them should be brief and simple. It may be easier to get an hour-long appointment with a city councilman than to capture the attention of the layman for fifteen minutes.

As was the case with the Interview Guide, it is possible here to provide only some general guidelines for the design of the questionnaire. A sample questionnaire is presented in Appendix B.

1) The questionnaire should be designed primarily to identify response to a series of specific conservation measures. As with the Interview Guide, it is suggested that the measures to be assessed include at least one from each classification category (see Table 3-1).

Other measures of special relevance to a given Corps site should be added.

Of course, the nature of a questionnaire precludes an open-ended examination of a respondent's evaluation of a conservation measure. Rather, a respondent's assessments are structured and constrained by the instrument; his task is merely to choose from among a set of responses presented to him. It is important then, that the Corps build into the structure of the questionnaire whatever categories of information they want from it. There is no leeway, no room for discussion as is provided by an interview.

It is suggested that at least five dimensions of public response to each conservation measure examined be identified:

(1) How much does the respondent know about the particular measure.

(2) How well does he think it will work.

(3) How economical does he think it would be.

(4) How serious would the need for conservation have to be before he would adopt it.

(5) Overall, how does he evaluate the measure.

2) Brevity is a concern that applies not only to the questionnaire, that is, to the number and length of the questions asked; it must be applied as well to the length of the responses demanded. Thus, it may take a second or two for a respondent to read an open-ended request to evaluate a half-dozen listed conservation measures. But it would take considerable time and effort for him to organize his thoughts and to write them down.

On the other hand, it would require but a minute for him to provide evaluations if the instrument had already structured his responses, that is, presented him with categories of response from which he had but to choose and check. Of course, one "pays" for the ease of this response in that it is restricted to the categories provided.

3) Another essential in the construction of a questionnaire for the general public is that its language be that of the common vernacular -- direct, simple and jargon-free. Thus, for example, a question dealing with pricing as a conservation measure should not speak of "increasing block rates," but rather of the price per gallon of water increasing as more water is used. It is far better to say something in plain words even if it requires greater length and an inelegant style.

4) Of course, it is crucial that the wording of a question not bias response to it. This is easier said than done. It is sometimes extraordinarily difficult to phrase something neutrally. How, for example, does one inquire into the health concerns respondents may have about the use of renovated wastewater without creating them. To ask a question about such concerns says there are some. There is no simple solution to this problem, only the caution that extreme care be exercised.

Perhaps here, at the conclusion of these few general considerations on the design of an interview guide and a questionnaire, belongs a discussion of the possible use by the Corps of consultants in studying the social acceptability of conservation measures.

Although practical problems may dictate the extent of their involvement, there are usually no prejudicial obstacles to the use of experts in areas which clearly call for particular knowledge and skills absent in a Corps staff. But the use of behavioral scientists often poses a special problem. So much of the subject matter of psychology and sociology is the subject matter of everyday life, so much of their vocabularies is familiar, and so many of their conclusions so speculative, that psychologists and sociologists are often not seen as experts, as exclusive possessors of a body of knowledge and skills, in the same way, say, as are chemists or geologists -- fields that have private languages and private processes and technologies. The claim of social scientists to a monopoly of expertise is often not respected.

Perhaps somewhat deservedly so. Perhaps they have pretentions. Nevertheless, it is the case that training and experience in the behavioral sciences is of major, if not decisive, assistance in the design and execution of a study whose purpose is to measure the <u>social</u> acceptability of conservation measures. No manual, however detailed, can substitute for it. Suggested guidelines can provide general direction, can specify what must be done, and can warn of obvious pitfalls, but the subtleties of phrasing or sequence in a questionnaire, the arts of beguilement and confrontation in the conduct of an interview -- these are the talents and skills that define the professional researcher. If then, practical considerations permit, Corps offices would be well-advised to avail themselves of such services.

There is a further reason, of a different order, to involve professional researchers, namely, their non-Corps status. Interview respondents may perceive Corps staff as interested parties and this may color their discussion; one can be more open with a disinterested professional.

4. <u>Data Collection</u>. Once the design of the two instruments for the two samples has been accomplished, attention shifts to the techniques of implementation. These are more straightforward.

For the Interviews. 1) A letter should be sent to each potential respondent inviting him to be interviewed. It should state, in general terms only, the over-all purpose of the study; it should explain, in general terms only, how he was selected; it should include a calendar of dates and times and sites from which he can select an appointment at his convenience; it should provide a stamped and addressed envelope for his reply; it should assure him of a confirmation; it should provide him with a name and number for further information. Finally, the nature of the invitation should persuade him that it is a compliment to have been selected. Care should be given to the stationery used; letters must appear to be individually typed and signed.

2) The respondent should be phoned and the appointment confirmed.

3) Although no manual can tell someone how to execute a good interview, a few general suggestions can be made. First, the interviewee should have memorized the guide; it should be automatic so that following it doesn't interfere with paying attention to the respondent. Second, at the same time, he should be able to disregard the guide at some point if it interferes with rather than facilitates the over-all goal. Thus, the good interviewer permits, even encourages, a respondent to wander, if he knows that what might seem to be far afield from a literal reading of the guide, is, in fact, directly relevant. In other words, it is the goal, not the guide that should be kept uppermost in the interviewer's mind. Third, the interviewer should not be afraid of confronting the respondent. While certainly polite and respectful, the good interviewer is not reluctant to press a respondent -- he may question an argument, point out a logical inconsistency, doubt a figure, etc., etc. -- all to the end of clarifying the respondent's position. Fourth, an interviewer must not promise what he can't deliver; there should be no assurance of "sharing the results" of the study unless it is absolutely certain that they will be. Fifth, an interviewer must be perceived as nonjudgmental; that is, he must convey an attitude of acceptance and understanding regardless of the position being offered. This is different from agreement, either actual or hypocritical; it is, rather, an expression that the contribution being made by the respondent has value. Thus, even though an interviewer may question or disagree with a respondent, at the same time, he must always convey his belief in the genuineness and personal legitimacy of the respondent's discussion.

4) A thank you letter should be sent to each respondent from his particular interviewer.

For the Questionnaire. 1) The envelope is the first "communication" of a mail questionnaire. Care should be taken as to what it says. The identity of the sender is one message. The physical properties of the envelope -- its size and color and quality of paper -- all enter into how the request for participation will be received. And perhaps most important, the way the respondent's name and address have been typed -- automatically on a sticker or hand-typed directly on the envelope, speaks clearly to the potential subject of his importance to the study.

2) An addressed and postage paid envelope must be included to facilitate the return of the questionnaire. It is probable that the use of an actual stamp increases the rate of return in that it constitutes a slight social pressure for its proper use; envelopes printed so that postage is paid only if used do not have this advantage. The questions of postage costs versus possible rate of return benefits must be weighed.

5. Analysis of Data. Once the interviews have been completed and the questionnaire returned, analysis can begin.

The Interview Data. Analysis of the interview data is essentially qualitative. Of primary interest is the identification of the core ideologies, those basic values and attitudes that are at work in the community, that power the opinions and behaviors of important groups. Of course, this is not to say that there is not interest in determining how frequently one encounters a certain pattern of social values; frequency would constitute a rough indication of how pervasive a value was, of the extent to which it was shared by different groups. But, the single voicing of an ideology, depending on its salience, on who says it, and its relevance to conservation, can figure as importantly as values that are widely but less powerfully held.

Analysis of the interview data can be conceptualized as involving two processes: first, there is the ordering and abstracting of individual statements. A respondent may go on at some length and with some heat about the state "poking its nose into our affairs when it tries to dictate where we can locate the treatment plant"; he may subsequently be equally vehement about "the federal bullies in Washington who've never been west of the Mississippi telling us what we can and cannot do." It is clear that a general point may be drawn: intense commitment to the autonomy of local government; resistance to, and resentment of, higher jurisdictions. It is such translations of ideosyncratic material into general statements, done again and again, that lead to the identification of core values and finally to the characterization of ideological systems.

The second process involved in the analysis of interview data is that of interpretation. By definition, interpretation is subjective, a matter of judgment, an art. And a necessary one. It is what gives data meaning. Although speculative, the logic of an interpretation should be visible in the argument for it -- thus, the audience has the option of being convinced or not as they find it more or less persuasive.

Of course, a manual cannot give detailed directions on how to interpret data, it can only emphasize that it must be done. However, perhaps a few brief examples of the process will prove useful.

1) When discussing urban growth, a respondent uses a series of metaphors all of which liken growth to natural forces -- the tides, the wind, the rain, the frost-dates. The interpretation is that he sees urban growth as being outside of man's control, as not subject to human effort.

2) A respondent argues that it is wrong to use government -- zoning laws, building codes, sewage facilities, etc. -- to limit or control urban growth, illustrating his point by referring to the "unholy mess created by Wallace and his agricultural programs to elevate farm prices under Roosevelt." The interpretation is that he applies an economic principle to what others would define as a civil/political issue.

3) A respondent discusses the political take-over of the city by those "on welfare -- the Blacks and the poor whites in from the hills." He is angry that those who've made it by hard work should have to support the "undeserving." Later, he criticizes the "nonsense" of affirmative action by asking: "Why should someone get ahead because of their color?" The interpretation is that his exclusive application of the single criterion of merit as the only legitimate determinant of the distribution of social benefits is possible only if there is a denial of social disadvantage. That is, the logic of his position rests upon the assumption of an equal start in life. In his mind, those who win the race, deserve to, and those who lose, deserve to, because everyone has started from the same place. If he bought the idea that people start at different distances from the finish line, he wouldn't be able to maintain his argument.

Even these three brief examples of increasing complexity are sufficient to indicate the kinds of conceptual leaps inherent in the process of interpretation.

The Questionnaire Data. Analysis of the questionnaire data is essentially quantitative. The responses are scored and those scores tabulated and manipulated in various ways.

The first step is straightforward -- determining how responses are distributed in the sample. For example, what percentage of respondents rated the use of renovated wastewater (or pricing, or plumbing appliances, etc.) positively and how many rated it negatively. Just this simple kind of arithmetic processing can yield much data of much importance. Thus, one could derive a rank order of conservation measures based upon their over-all evaluations; and one could determine if such ranking differed depending upon such social characteristics as age or education.

But far more complicated questions can be asked of such data. For example, if the questionnaire had respondents rate the effectiveness, efficiency, and social acceptability of a conservation measure, say, pricing, an analysis of variance would reveal which of these --

effectiveness, efficiency or acceptability, figured most importantly in determining pricing's over-all desirability as a conservation measure.

Questionnaire data also often demand interpretation. For example, the public of two cities may answer differently to the same question; the citizens of one may be far more knowledgeable about every conservation measure presented than the citizens of another. This fact only becomes meaningful when put in the context of the fact that the first city is situated in a desert, that water there is rare and precious, and their need for conservation and the methods of conserving are kept constantly visible in the media.

The explanatory connection made above may seem obvious, and therefore not be considered an "interpretation." But on the same logic -- the greater aridity of a region bringing about greater awareness of the need for conservation and the ways of achieving it -- one would predict that an "arid" city would be more willing to accept legally imposed regulations and sanctions to the end of conserving water. This is "obvious" too, a conspicuously reasonable argument, and it would indeed be an "explanation" for such a finding. But if the finding fails, if the data don't fall that way, if, in fact, the opposite proves to be the case, one is forced to depart from the obvious and seek elsewhere for an "explanation." Thus, in the illustration just cited, one might note that the arid city was also a city characterized by a political philosophy in which any government controls or regulations were seen as odious interferences with free enterprise. And one might then conclude that it was this ideological stance that countered the predicted influence of the region's aridity on the acceptability of using law to promote and enforce conservation.

Agreement or disagreement with the persuasiveness of the above example is not important here; the point that is important is that interpretation is necessary if the data are to have meaning.

6. Determination of Social Acceptability. The last step in a study of the social acceptability of water conservation measures is at the same time the most important and most tenuous. It is useful to recall the definition given at the beginning of this appendix -- a conservation measure was seen to be more or less socially acceptable as it was more or less congruent with the social ideologies or value systems of those who hold the power of decision (usually both community influentials and the general public).

The concluding task then, is clear. Having identified who holds what values, having some sense of what ideologies prevail, each and every specific conservation measure can be examined in their light. For example: Who would be for increasing block rates and why, who would be opposed to them and why, what would it take to change their minds, are the community influentials and the general public in agreement on pricing, if not could one be used as leverage against the other; what, then, are the chances for its adoption in the community. These are the kinds of questions to be asked and which the study's data, if it cannot answer, can at least instruct.

Perhaps the most appropriate analogy for a study of the social acceptability of conservation measures is that of a voyage into unknown waters made in a vessel of doubtful seaworthiness. At least such a comparison honestly admits the difficulties of subject matter and the weaknesses of method.

But what is the alternative? The reality is that values and attitudes and beliefs, reasonable or unreasonable, figure decisively in how man behaves. It does no good to deny or ignore that fact. Rather, the acknowledgment of their power and the understanding of their force, however incomplete, are actions that promise a more effective use of Corps resources and a more successful implementation of Corps policies.

APPENDIX B

SAMPLE QUESTIONNAIRES

INSTRUCTIONS: Down the left side of the paper, several ways of conserving water are described. Please tell us your reactions to each of them by answering the 5 questions asked *across* the top of the page. For example, read the description of Conservation Measure A, and then answer all 5 questions about it by checking that one of the 4 spaces under each question that best expresses your opinion. When finished, please fill out the background information and then return the questionnaire to us in the enclosed postage-paid envelope. We are most grateful for your cooperation.

	Question 1 *How much do you know about this particular water conservation measure?*				Question 2 *How well do you think it would work?*			
	know nothing	know just a little	know a fair amount	know quite a bit	wouldn't save any water	would save only a very little water	would save a fair amount of water	would save a lot of water
CONSERVATION MEASURES								
A. Individuals install new water-conserving plumbing fixtures such as low-flow toilets and shower heads in their homes.								
B. City and state governments engage in active campaigns to educate the public on how to conserve water.								
C. Sewage is processed and the treated water reused for manufacturing and irrigation of crops.								
D. Building codes require the installation in new buildings of water-conserving plumbing fixtures such as low-flow shower heads and toilets.								
E. As the amount of water used increases, the price per gallon is raised.								
F. The city controls the rate of urban growth and thus the demand for water by issuing only a limited number of building permits each year.								
G. The use of water for lawns and gardens is reduced by half.								
H. During a severe drought, the government imposes restrictions on water use that if violated result in stiff fines.								

To be effective, some of the measures described above would have to be made into law and enforced by government. *Generally, how would you feel about this?* (Please check one)

I would be strongly opposed	I would be *somewhat* opposed	I would be *somewhat* in favor	I would be strongly in favor
____	____	____	____

2

...stion 2 ... think it		Question 3 How economical do you think it would be?				Question 4 How serious would the need for water conservation have to be before you think this measure should be adopted?				Question 5 Over-all, how do you evaluate this conservation measure?			
would save a fair amount of water	would save a lot of water	it would cost more than it would be worth	probably come out even, it would cost as much as it would save	it would result in saving some money	it would result in big savings	not at all serious	slightly serious	moderately serious	very serious	it is totally unaccep-table to me	not too good, I don't approve	pretty good, I approve	excellent, I enthus-iastically approve

BACKGROUND INFORMATION

Age: ______ Sex: ______ Occupation: ______________________________

Education:
- Less than High School graduate ______
- High School graduate ______
- Some College ______
- College graduate ______
- Some graduate work ______
- Masters level degree ______
- Some doctoral work ______
- Doctorate ______

INSTRUCTIONS: Down the left side of the paper, several ways of conserving water are described. Please tell us your reactions to each of them by answering the 5 questions asked across the top of the page. For example, read the description of Conservation Measure A, and then answer all 5 questions about it by checking that one of the 4 spaces under each question that best expresses your opinion. When finished, please fill out the background information and then return the questionnaire to us in the enclosed postage-paid envelope. We are most grateful for your cooperation.

	Question 1				Question 2				Quest	
	How much do you know about this particular water conservation measure?				How well do you think it would work?				How economic think it wo	
	know nothing	know just a little	know a fair amount	know quite a bit	wouldn't save any water	would save only a very little water	would save a fair amount of water	would save a lot of water	it would cost more than it would be worth	[illegible]
CONSERVATION MEASURES										
A. Individuals install new water-conserving plumbing fixtures such as low-flow toilets and shower heads in their homes.										
B. City and state governments engage in active campaigns to educate the public on how to conserve water.										
C. Sewage is processed and the treated water reused for manufacturing and irrigation of crops.										
D. Building codes require the installation in new buildings of water-conserving plumbing fixtures such as low-flow shower heads and toilets.										
E. As the amount of water used increases, the price per gallon is raised.										
F. The city controls the rate of urban growth and thus the demand for water by issuing only a limited number of building permits each year.										
G. The use of water for lawns and gardens is reduced by half.										
H. During a severe drought, the government imposes restrictions on water use that if violated result in stiff fines.										
I. Farmers in the region grow only those crops which require relatively little water; crops demanding large amounts of irrigation are not grown.										
J. The landscaping of new homes uses only those plants that are adapted to the aridity of the region and require little water.										

To be effective, some of the measures described above would have to be made into law and enforced by government. Generally, how would you feel about this? (Please check one)

I would be strongly opposed	I would be somewhat opposed	I would be somewhat in favor	I would be strongly in favor
____	____	____	____

2

Question 2			Question 3				Question 4				Question 5			
you think it			How economical do you think it would be?				How serious would the need for water conservation have to be before you think this measure should be adopted?				Over-all, how do you evaluate this conservation measure?			
[illegible]	would save a fair amount of water	would save a lot of water	it would cost more than it would be worth	probably come out even, it would cost as much as it would save	it would result in saving some money	it would result in big savings	not at all serious	slightly serious	moderately serious	very serious	it is totally unaccep-table to me	not too good, I don't approve	pretty good, I approve	excellent, I enthus-iastically approve

BACKGROUND INFORMATION

Age: ______ Sex: ______ Occupation: ______________________

Education:
- Less than High School graduate ______
- High School graduate ______
- Some College ______
- College graduate ______
- Some graduate work ______
- Masters level degree ______
- Some doctoral work ______
- Doctorate ______